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WATER POLLUTION ASPECTS OF URBAN RUNOFF

American Public Works Association
Chicago, Illinois

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WATER POLLUTION ASPECTS OF URBAN RUNOFF

Final Report on The Causes and Remedies of Water Pollution
from Surface Drainage of Urban Areas-Research Project No. 120

of the

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
U.S. DEPARTMENT OF THE INTERIOR

by the

American Public Works Association

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Abstract

A study was conducted to determine the factors in the urban environment which contribute to the pollution of urban storm water runoff and to determine methods to limit this source of water pollution. It was found that street refuse—litter—could be a significant factor when the nature of the shock discharge of the pollution is considered.

An evaluation was made of the efficiency of street cleaning methods and limitations of commonly used equipment explored.

Catch basins in conjunction with street inlets to the storm water disposal system were also determined to be a potential major source of pollution as large quantities of septic liquid are released during periods of storm water runoff.

Other potential sources of pollution considered included air pollution, roof discharges, and chemicals used in the urban environment. Surveys were made to determine national patterns, a comprehensive set of "typical" ordinances governing a wide sampling of possible sources of urban storm water runoff pollution were compiled and are included in the report.

Findings and Recommendations are included in summary form.

This report is submitted in fulfillment of Contract WA66-23 between the Federal Water Pollution Control Administration and the American Public Works Association.

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Section 1

Findings and Recommendations

Under a contract with the Federal Water Pollution Control Administration the American Public Works Association has carried out a searching investigation of the sources and extent of water pollution resulting from the surface drainage of urban areas. The information sought has been brought to light by means of actual field studies in representative urban areas, national surveys of municipal sanitation practices and policies, and studies of specific technical problems by staff and advisory personnel.

The studies have brought to light out-of-doors environmental pollution factors in combined sewer and separate storm sewer discharges which are not included in the "conventional" concept of water pollution sources such as those stemming from used water discharged from homes, commercial establishments, and industries. This insight into community wastes of a solid and gaseous origin, and the evaluation of them as specific sources of water pollution, is important because so little attention has been paid to these pollution potentials in the past. If today's concern over sewage and industrial wastewater pollution results in the elimination or minimization of the more obvious sewage and industrial waste threats to the nation's water resources, and if intensive investigation of ways to reduce the effect of combined sewer overflows on receiving waters paves the way for correction of this problem, the "secondary" sources of pollution with which this project has been involved will take on greater importance.

This project has provided much-needed data on the sources of these environmental wastes of urban areas, the nature and amounts of contaminants, and their potential pollutional effects resulting from the water-wastes interfacial contacts during precipitation and runoff incidents. It is true that some of the study data have been preliminary in nature; this does not detract from their validity. It is merely evidence that much of the work carried out under this project has been of an original nature and that such studies as these are intended to point out the need for further work in uncovering more facts and reaching additional findings and recommendations.

Thus, this project has had two values: It has provided procedures for measuring the water pollution potential of urban environmental wastes and evaluating their water resources effects in comparison with so-called "conventional" water pollution sources; and it has disclosed the relationship between better urban "housekeeping" practices and policies and the reduction of water pollution threats, thus adding another reason for community cleanliness and beauty.

The study has made it possible to reach the following Findings, and offer the following Recommendations.

Findings

1 Street refuse — litter — creates a water pollution potential when it comes in contact with runoff waters resulting from precipitation or thaws, in direct proportion to the amount and nature of these urban environment wastes. This pollution potential can be reduced and minimized by better municipal sanitation practices, the use of more sophisticated equipment, and improved public cooperation and participation.

2. Water pollution from storm-water runoff can affect many American communities. A study "Problems of Combined Sewer Facilities and Overflows—1967," by the American Public Works Association under contract with the FWPCA, disclosed that 1,329 municipal jurisdictions, with a total population of 54 to 55 million, are wholly or partially served by combined sewers. Thirty-six million persons are directly served by combined sewers. Some 70 million urban residents are served by separate sanitary sewers, of whom perhaps 60 to 65 million are also served by separate storm sewers. The urban population explosion of the next three decades could increase the potential water pollution hazard from street wastes and related out-of-doors wastewaters by extending storm-sewer conduits and increasing the amounts of manproduced litter accumulations.

3. The amount of street litter deposited from various sources was determined, by a study of 18 test areas of representative occupancy, land use and other zoning characteristics, to vary from 0.5 to eight pounds per 100 feet of curb per day. The average varied from 4.7 pounds per day per 100 feet of curb for commercial areas to 2.4 pounds per day per 100 feet of curb for single family residential areas. The amount and nature of street litter was found to vary with land use, population, traffic flow, and other indigenous factors. The actual amount of litter material on the street at any one time is largely dependent upon the frequency and effectiveness of street cleaning operations. A national survey of street sweeping and flushing operations demonstrated a broad range in frequency of sweeping, with many areas cleaned on an every other week schedule.

4. The most significant component of street litter, in terms of producing water pollution potential by runoff, is the dust and dirt fraction, as found in the test street areas, varied from 0.4 to 5.2 pounds per day per 100 feet of curb. The weighted average was 1.5 pounds per day per 100 feet of curb. Of this material, approximately three percent were found to be soluble and readily transportable. This represents the solids subject to the creation of water pollution potential.

5. This soluble dust and dirt contained appreciable amounts of water pollution contaminants measured as: BOD, COD, nitrogen forms, phosphates, total bacteria counts, coliforms, and fecal enterococci. The weighted average amounts of these constituents were respectively: 5 mg/g, 40 mg/g, 0.48 mg/g, less than 0.05 mg/g, more than 10

million, more than 1 million, and 5400/g. Analysis of the dust and dirt fraction was carried out on liquid extractions produced by a laboratory mixing device. This procedure gave a "maximum solubility" which may not be reproducable with storm-runoff conditions. On the other hand, the constituents tested did not include the coarser street litter (over 1/8 inch).

6. Coarse or crude materials in street litter—the materials of over 1/8 inch size—also have pollutional impact on receiving waters. These visible suspended solids can be washed into street inlets of storm and combined sewers and create objectionable conditions at sewer outlets when they float or shoal in receiving waters. In addition, some of these materials may decompose and create additional oxygen demands upon receiving waters.
7. The most determinable measure of pollution potential of street litter was deemed to be the BOD of the soluble dust and dirt fraction. This BOD varied from three to 14 mg/g of dry material. As stated, the average was 5 mg/g. This amounted to 0.40 pound of BOD per day per curb mile. Compared to the BOD reduction of 80 percent considered attainable for secondary treatment of sewage, the BOD of the street litter was equivalent to 25 persons per day per mile. National population densities per mile of roadways and streets indicate that for a city of Chicago's size, 500 persons would live adjacent to each mile of street. Thus, with a street litter BOD equivalency of five persons per day per mile, street litter would have a pollution potential of one percent of the raw sewage pollution loading and five percent of the secondary treatment effluent described above.
8. On the basis that contact between street litter and precipitation runoff water could occur with a 14-day accumulation of material, and that all of the soluble and transportable BOD in the dust and dirt fraction would be discharged into street inlets during a two-hour storm, the shock pollution load, or the peak flush effect, on receiving waters per mile of street could be 160 percent of the raw sewage BOD and 800 percent of the secondary treatment effluent during the two-hour runoff period. If the runoff occurred during night hours of low sewage or effluent discharges, the comparative effect of street litter contaminated runoff would be greater than these average figures. Marked oxygen sags could result in the vicinity of storm-water overflows or discharges. The shock effect of other street litter contaminants on receiving waters has not been ascertained but it could be appreciable, particularly in terms of coliform and fecal-orgin organisms which could degrade recreational waters and endanger water supplies.
9. Street litter stems from various sources and practices including debris dropped or scattered by individuals; sidewalk sweepings; debris washed from vacant land, yards and other indigenous open areas; building and demolition wastes; materials eroded from

pavements; fecal droppings from dogs and birds and other animals; remmants of household refuse dropped during the course of collection or scattered by animals or wind action from containers; fallout of air pollution particulates; and dust and dirt blown by winds. Whatever is done to eliminate or reduce the wastes will result in a diminution of the runoff contact and pollution potential and in a cleaner and more attractive community.

10. Street sweeping equipment and methods of operation vary widely according to a national sampling survey carried out in connection with the project. A field survey showed the relative ineffectiveness of broom sweeping in the removal of the dust and dirt fraction of street wastes, an important source of water pollution potential. Additional studies were made to ascertain the effectiveness of vacuum cleaning equipment for municipal street cleaning. The tests demonstrated the ability of such equipment to remove dust and dirt fractions remaining after mechanical sweeping operations. Removal of more than 95 percent of the material from the surface over which it operated was accomplished during the tests. However, presently available equipment does not appear suitable for complete removal of street wastes or litter which contains appreciable amounts of clay.

11. Catch basins can be a source of first-flush or shock pollution. The studies disclosed that the liquid remaining in a basin between runoff events tends to become septic and that the solids trapped in the basin take on the general characteristics of septic or anaerobic sludge. The liquid in catch basins displaced by fresh runoff water in the ratio of one-half the volume for every equal volume of added liquid. During even minor rainfall or thaw this displacement factor can release the major amount of the retained liquid and some solids. The catch basin liquid was found to have a BOD content of 60 ppm in a residential area. For even minor storms, the BOD of the catch basin liquid would be seven-and-one-half (7-1/2) times that of the runoff which had been in contact with street litter. Improved design of catch basins, and better operational and maintenance practices, could reduce this first-flush pollutional effect.

12. Drainage from roofs into storm and combined sewers results in the washout of pollution-producing materials such as air pollution fallout particulates, leaves, and bird and animal droppings. The amount of runoff water adds to the hydraulic burden on sewer lines. If this material and roof liquid could be discharged onto previous ground areas or temporarily impounded, the peak runoff to sewers could be reduced.

13. The chemical era has produced street and additional urban environmental pollutants such as salt and other ice-control chemicals used during the winter season; and chemical compounds used by municipalities and property owners for pesticide, herbicide, rodenticide, insecticide, and fertilizer purposes. Chemicals used become potential components of runoff or thaw waters which enter street

inlets and affect the quality of receiving streams. No data were developed on chemicals other than salt, but the latter represented a sizable pollution potential.

14. A national sampling survey carried out for this study disclosed the extent of the use of various chemicals in urban practices. An investigation of the salt content of expressway runoff water showed that the chloride content averaged 14,000 ppm and reached a maximum strength of 25,000 ppm during periods of snow-melt runoff. A national survey of roadway salting and other ice-control methods showed the importance of this chemical phase of urban-environmental pollution.

15. Aerial discharges from industries, commercial establishments, and residential buildings add pollutants to the urban environment and these substances become water pollution potentials due to washout and runoff. This source of urban pollution should be minimized as current air pollution control measures become more widely used.

16. Another pollution source is the wash-water discharged into separate storm sewers and combined sewers by industries and commercial establishments after the use of these waters for air pollution control purposes. An attempt to evaluate this pollution source by means of an in-structure survey of representative industries using scrubbing facilities in the Chicago metropolitan area failed to materialize but examination of this problem has indicated that it can be a factor in urban environmental pollution potential.

Recommendations

On the basis of the findings of the studies, the following recommendations are offered. Remedial action and research of the nature herein proposed would reduce or eliminate the threat of water pollution stemming from contact between urban environmental wastes, and precipitation and runoff.

1. The studies established the relationship between street refuse—litter—and the pollution effect of urban runoff after contact with these wastes on the quality of water resources receiving storm sewer discharges and combined sewer overflows. The impact of the quantities and quality of these surface wastes on the pollutional potential is firmly established.

   It is recommended that efforts be made by governmental agencies to limit the amounts of litter accumulation by various means, and from various sources, in order to reduce their pollution effect and to enhance community cleanliness and beauty. This will involve, among other things, more frequent and more effective street cleaning procedures in areas where such efforts and expense are warranted.

2. Improved street cleaning procedures can result in more complete pickup of the dust and dirt fraction of street litter. Variations, for example, in the speed of sweepers and broom speed should be tested to determine their effect on pickup efficiency. The demonstrated efficiency of vacuum equipment likewise draws attention to this method of cleansing.

   It is recommended that further research be undertaken to develop improved street cleaning equipment and processes by governmental officials, manufacturers, and other agencies in the interest of water pollution control as well as community cleanliness and beauty.

3. Much of the street litter stems from the careless or thoughtless scattering of materials and other practices by the public. Reduction of the amount of street litter requires a full measure of public cooperation and participation.

   It is recommended that greater efforts be devoted to public education programs and to the establishment of effective and workable regulations and ordinances, relating to street cleanliness, and to their proper enforcement. This must include anti-littering campaigns, and regulatory measures such as those designed to control spillage of materials in transit. Public support, without which no such efforts can succeed, must be gained through education. Enforcement actions must be recognized as only a means toward the ultimate goal of voluntary public participation.

4. The principle of "go thou and do likewise" must be the guiding symbol in any community cleanup program. Governmental agencies must set the example before they can demand public action. Untidy governmental practices will never catalyze individual orderliness. The potential pollution effect of street wastes on the Nation's water resources adds an important incentive for urban cleanliness.

   It is recommended that governmental practices be improved in an effort to minimize accumulations of street debris. This must include the purchase and placement of convenient litter containers, maintenance of these receptacles in presentable condition, prompt collection of litter basket contents, maintenance of street sanitation equipment in attractive condition designed to encourage community pride and respect, better cleanliness practices on the part of waste collection forces, and, of course, better street cleaning operations with equipment of effective design. These examples must be accompanied by public relations efforts which utilize every available source of communication.

5. Too little study has been given to the actual quality of waste waters discharged into receiving waters from separate storm sewers and combined sewers. Previous studies of overflow waters disclosed the astonishing sparcity of monitoring information of this nature. This study has based its findings on empirical computations of the pollutional potential of street litter resulting from precipitation and

runoff contacts. It would be advantageous to know more specifically the characteristics of the runoff resulting from such interface contacts, as a means of confirming the computations made in this project.

It is recommended that an intensive research effort be made to determine the actual quality of representative discharges, particularly from storm-water sewers because these liquids will not be affected by the presence of sanitary sewage and industrial wastes. Such studies should cover discharges from areas with various ranges of accumulated street refuse and precipitation runoff, sampled during the complete discharge period to ascertain the first-flush effects and prolonged changes in runoff quality. The studies shall of course, include examination of receiving waters before and after discharge incidents.

6. Efforts made during the study to ascertain the movement and shoaling of solids in storm sewers and combined sewers after these materials have passed through catch basins were not successful. This resulted from the lack of time and inability to obtain meaningful data on sewer cleaning operations. The possibility of using closed-circuit TV equipment to obtain an approximation of the amounts and character of deposited material in various parts of sewer lines was considered. Unfortunately it was not feasible to use this technique for such an investigation. Information of this nature is sorely needed to augment present knowledge of what happens to suspended solids not intercepted by catch basins. Data obtained by a national sampling survey were not adequately revealing but they demonstrated the need for further information of this nature.

   It is recommended that investigations be carried out on the deposition and movement of solids in sewers under varying conditions of material inflow, and the intensity and duration of precipitation and runoff. Such studies will throw light on the value of catch basin structures as intercepting devices and indicate design and operation-maintenance practices which could increase their effectiveness, if their use is continued.

7. Ths use of catch basins as appurtenances of street inlet structures in separate storm sewers and combined sewers has been common in the past. This practice continues despite the fact that questions have been raised as to the need for these facilities with paved street surfaces and hydraulic flow patterns in sewer systems. The study has demonstrated the shock loading on receiving waters which could occur when septic liquid and sludge solids are dislodged and displaced from catch basins. The engineering evaluations made in connection with this study tend to support the position of those who question the need for catch basins in modern urban sanitation practice.

   It is recommended that the function and effectiveness of catch basins be more thoroughly investigated to determine the conditions *under which they may be useful, if and when they should be eliminated and what improvements should be made in their design, operation, and maintenance if their use is continued.*

8. The study indicated, at least in general terms, the potential impact of roof leader waste-water discharges into storm and combined sewers on the total water pollution attributable to wastes in the urban environment. This effect is magnified because of the rapidity with which roof drainage water reaches sewer systems, and the nature of the pollutants that it carries.

   It is recommended that studies be carried out on the quantity and quality of roof drainage waters under varying precipitation amounts and intensities at different times of the year. The advisability and feasibility of diverting such drainage waters to pervious ground, temporary impounding areas, or to leaching devices should be investigated.

9. Efforts made to determine the policies, practices, and quality of wastewater discharges from representative industries and commercial establishments using scrubbing or other water-processing methods of cleaning stack gases to alleviate air pollution emissions were not productive. Time was not available, nor was it possible, to obtain participation of private and public agencies in such a study. Information of this nature can be of value in determining whether such air pollution control measures contribute to the water pollution problem by discharging contaminants into storm or combined sewer systems.

   It is recommended that an investigation be instituted to ascertain the air pollution control policies, practices, and processes used by representative industries and to determine the amounts and the quality of wash waters discharged to sewers.

10. Entry of deleterious or hard-to-treat industrial wastes into sanitary sewers and combined sewers is being more universally prohibited in order to protect sewer systems and to assure the effectiveness of biological processes at water pollution control plants. Unfortunately some communities have no regulations prohibiting the discharge of wastes into separate storm sewers.

    It is recommended that the discharge of pollutional wastewaters into separate storm sewers be regulated by rules or ordinances and that enforcement of such pollution control practices be vigorously carried out.

11. The study defined, at least in preliminary manner, the pollution potential of residues from chemicals used in public or private operations, which are then washed out by precipitation and runoff and discharged into storm or combined sewer street inlets. This relates particularly to ice-control chemicals utilized in treating street and road surfaces.

It is recommended that a study be made of the pollutional effects of all types of urban environment chemicals on the nation's rivers, lakes, and coastal estuaries; and that guidelines be developed to discourage the use or over-use of any deleterious materials which can be replaced by less objectionable compounds for the same purposes.

12. The study indicated the pollution potential of street litter when contact is made with such materials by precipitation, runoff, and other drainage waters. The study used the soluble dust and dirt fraction of street litter as the measure of this pollutional hazard. It then placed emphasis on the BOD of these wastes as the tangible and translatable yardstick of water pollution in terms of the equivalent population effect on watercourses.

    It is recommended that studies be made to evaluate the pollutional effects of other constituents of street refuse, such as nitrogen and phosphate nutrients, total bacterial counts, coliforms and fecal enterococci organisms, on various water uses, including bathing and public water supply.

13. In all areas sampled during the field tests, relatively large amounts of dust and dirt were present even in completely built-up areas with limited pervious land in the immediate vicinity.

    It is recommended that a detailed analysis of street dust and dirt be made to determine the origin of the material in order that more effective control measures can be evaluated.

14. The cost of reducing pollution of surface drainage water from urban areas may be very high and in some instances it may become necessary to treat storm water runoff before it is allowed to be discharged into receiving waters.

    It is recommended that designers of separate storm and combined sewer systems minimize the number of outfall and overflow points within the limits of feasibility and practicality in order to reduce the number of points of treatment of such wastewater discharges, should such action be necessary.

Section 2

An Introductory Appraisal of the Water Pollution Potential of Surface Drainage from Urban Areas

The United States is experiencing a population explosion which has had a profound effect on the quality and usefulness of its water resources for the multiple purposes associated with national growth and progress. The problems of water quality degradation are caused mainly by the phenomenal growth of urban areas and the expansion of industrial operations which are centered in such areas or in their general environs.

The present national population of over 200 million may burgeon to well over 250 million by 1975 and to 300 million by the turn of the century. The bulk of the population is concentrated in urban centers and the metropolitan complexes which are filling in the spaces between communities. It is projected that industry will more than double the gross national production by the year 2000.

Successful urban existence is dependent on the protection of the environment in a safe and livable condition. The three basic essentials of a protected environment are clean air, clean land, and clean water. The problems of maintaining the vital ingredients of a sanitary environment against the thrust of urbanization becomes increasingly difficult as urbanization intensifies.

To meet this conflict of man and his industrial activities with a clean environment, public works and related urban sanitation practices have been devised to protect the air blanket from defoulment, to keep the urban land free from accumulated debris, and to protect water resources from pollution which may affect man's ability to use and reuse this great resource essential for national growth and prosperity.

Every use of water exposes it to contamination and creates the threat of quality degradation. The unending cycle of water in the environment is from contamination to purification and then back to contamination. The moisture evaporated from land and air surfaces and transpired from vegetation is purified by nature's own distillation process, leaving indigenous pollutional components behind. The precipitation of the condensed atmospheric moisture begins another contamination cycle.

The fall of rain and snow through the atmosphere cleans the air by dissolving out contaminants and physically washing out particulate matters. The flow of waters over the land in the form of runoff to watercourses adds further soluble and insoluble natural contaminants to the water cycle. Even the percolation of waters into the soil and their eventual flow into watercourses and lakes adds soluble and insoluble substances which may or may not be of a pollutional nature. Thus, even

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without the effect of man's urban existence, nature creates pollutional conditions.

The urban environment magnifies these pollution producing conditions. The air washing of the urban atmosphere contributes more and more diverse pollutional substances to precipitation. The drainage of the urban area adds contaminants that far exceed those nature-induced pollutants added to runoff by solution and erosion in open non-urban areas. The conversion of pervious open land to impervious urban surfaces, such as roads, walks, streets, roofed structures, parking areas, shopping centers, and airports, produces greater faster runoff along with scour pollution. The use of water for public and industrial services produces waste waters containing the waste products of human life and living as well as industrial processing.

The discharge of these wastes into receiving waters constitutes the major water pollution problem. The ever-increasing amounts of such pollutants and the growing complexity of these water-borne wastes have created a deepened concern for the safety and usefulness of the nation's water resources and have led to action on state, federal, and interstate levels to consummate massive cleanup programs in the next decade.

Efforts are being directed toward the elimination of obvious and major sources of pollution—the discharge of untreated or inadequately treated municipal sanitary sewage and industrial wastes—the goal being appropriate treatment of all such waste waters. However, control over what might be called "gross pollution" from these sources will not adequately protect the nation's water resources. Ultimately, attention must be directed toward dealing with the less obvious pollutional vectors which have been relatively disregarded while large amounts of sewage and industrial wastes went untreated or were only partially purified. Progressive reclamation of the nation's water resources dictates that other sources of pollution must be examined and evaluated in terms of their relative importance as water degradation factors. Ways of eliminating or abating them, the costs involved, and the benefits to be derived must be ascertained.

In the category of less obvious pollution sources are (1) recurring overflows of admixed sewage and industrial wastes with storm water flows in combined sanitary-storm sewers; and (2) recurring separate storm sewer discharges during periods of precipitation, thaw or runoff, and drainage from other sources.

The problem of combined sewer overflows and means for minimizing the same is being investigated at an intensive rate and on an extensive scale, primarily with the support of demonstration and matching grant funds appropriated and administered for this purpose by the Federal Water Pollution Control Administration, Department of the Interior. Evaluation of the problem and demonstration of the effectiveness of various types of control and/or treatment of combined sewer overflows are underway in a number of communities and research location in various parts of the country.

In 1965, "A Preliminary Appraisal of the Pollution Effects of Storm Water and Overflows from Combined Sewer Systems" was prepared by the U.S. Public Health Service. It focused attention on the widespread use of combined sewers and resultant overflow episodes that contribute to the pollution of receiving waters.

The American Public Works Association conducted a detailed investigation titled "Problems of Combined Sewer Facilities and Overflows—1967" for the Federal Water Pollution Control Administration. The study was designed as a "National Inventory of the Effects and Means of Correcting Combined Sewer Overflows and Separate Storm and Sanitary Sewer Discharges in the United States." References to separate storm sewers as a source of pollution in this study are significant as precursors of mounting interest in the pollutional wastes which have been discharged untreated from these drainage facilities. Thus, pollution from sanitary sewers, combined sewers, and separate storm sewers, must be considered in the total pollution abatement program.

There is a direct relationship between the cleanliness of the urban environment and the cleanliness of storm-water runoff—or, conversely, between poor urban housekeeping and the pollutional effect of runoff waters which come in contact with urban-created street and land debris and aerial pollutants. Regardless of the sources of urban pollution of this nature, the connecting link is the street inlet structure to the separate storm sewer or the combined sewer. The relationship between urban cleanliness and water pollution appears obvious; what is not so obvious is the extent of this relationship and what can be done to eliminate or reduce it. So little has been done in the past to correlate the influence of street debris and air pollutants with the delivery of these contaminants to separate storm or combined sewers, precipitation, and runoff, that the problem must be approached as a relatively unexplored area of urban operations.

However, it must not be assumed that all runoff pollution is man-made and urban-based. Contamination of land runoff in rural and semirural regions results from the solution and physical entrainment of land organics, animal wastes, fertilizers, fungicides, herbicides, algaecides, rodenticides, pesticides and other chemicals, as well as eroded soils. While it is true that the perviousness of open land and natural topographic conditions impede runoff and pollution, this facet of water pollution cannot be ignored.

This project is aimed at defining the nature of urban pollution via street entry into storm and combined sewers. This involves a quantitative evaluation of the pollutional impact and its relative importance compared to known sewage and industrial wastewater discharges. In addition it leads to development of guidelines for the introduction of municipal practices to minimize these pollution sources by means of economical and feasible changes in equipment operations, regulations, and controls.

The earlier APWA study previously referred to disclosed that there are some 1,329 municipal jurisdictions in the United States served totally or partially by combined sewers. They have a population of 54 million with approximately 36 million served directly by combined sewers. The national urban population reported to be served by either combined or separate sanitary sewers as of 1962 was 125 million. Thus, the population served by separate sanitary sewers may have been approximately 70 million (125 million minus 54 million). A majority of the areas served by separate sanitary lines are also now served by separate storm sewers for drainage purposes, or they will be when urban development requires the prompt removal of storm waters. Since the areas not sewered with separate storm lines are, in the main, lightly populated, it may be assumed that upwards of 60 to 65 million persons reside in areas so served.

Separate storm sewers, as well as combined sewers, are potential recipients of the type of urban pollution to which this current study addresses itself: *street litter and airborne debris*. In addition these separate storm conduits are utilized as discharge points for other wastes not classified as "out-of-doors" pollutants that are the result of urban environment conditions. These other waste waters include: so-called clean waters discharged from cooling and refrigeration systems, contaminated waters from stack-washing operation in commercial and industrial establishments, and surreptitious or illegal discharges of actual waste waters from commercial and industrial operations into separate storm sewers. Indeed, it is not unknown for municipalities to provide relief for surcharged sanitary sewers by diverting their excess flow into storm sewer systems. In some cases, illegal discharges of individual septic tank systems have been made into convenient separate storm sewer lines.

In combined sewers, waste discharges can be considered, more or less, as indigenous components of the combined sanitary storm-water flows. In the case of separate storm sewers, these pollutants are not treated and they add a burden to receiving waters. Their elimination may be a problem of enforcement of regulations, the enactment of rules where none exists, and the institution of surveillance programs to insure compliance with rules and regulations. This project focuses attention on the need for better urban land and air sanitation practices and on the importance of regulations covering the use of separate storm sewers. Control of separate storm sewers is an additional step in sewer control designed to supplement present trends to regulate the use of sanitary sewers and combined sewer systems.

Section 3

Objectives and Goals of the Study

The proposal for the study stated the need for the investigation of the sources of urban storm water runoff pollutants and their magnitude. In investigating the pollution of storm-water runoff, the principal objective was to evaluate those factors affected by public works practices that may be controllable by changes in governmental operations and the enactment and enforcement of rules and regulations.

Without doubt, the impact of the normal waste flows from municipalities and industries exceed the effects of the sporadic pollutional discharges examined by this project. However, as these main sources will be subject to continuing reduction by adequate sewage and industrial treatment facilities, attention must center on other contributors to the overall water pollution problem. It is significant that interest already has been aimed at correction, or at least alleviation, of the combined sewer overflow problem; now, the impact of urban drainage on protection of the safety and usefulness of the nation's water resources deserves consideration.

This "stage approach" to the subject, with first efforts on the main problem and subsequent action on the other significant though lesser pollutional factors, is a rational application of the principle of cost-benefit evaluation of public expenditures. The questions involved are: how much of a factor is urban environment pollution, does it merit correction, how can it be done, how much will it cost, and what benefits will be derived? Study of the impact of urban environment pollution on water pollution and the identification of the component ingredients and amounts of such environmental contaminants indicates that a problem of some degree exists and that it may be corrected or minimized by governmental sanitation procedures.

Expressed in another way, over and above the identification of the so-called secondary pollutional factors involved in storm-water runoff and washout phenomena, the project has a more sustained function, namely: to correlate the nature and amounts of such pollutants with governmental practices, to alert the public and governmental officials regarding methods for solving the problem at least in part, to inform the public of its responsibilities for making the urban environment less of a water-pollution factor, and to provide guidelines for the practice of preventive and corrective measures that can stand the test of practical workability and economic feasibility.

This investigation involves facets of governmental operations that have remained relatively unexplored and unevaluated in terms of water pollution, such as street sanitation practices, use of insecticides, pesticides, herbicides and fertilizer chemicals in public work and by urban residents; use of chemicals for ice and snow control and for the inhibition of corrosion; and air pollution and control procedures that affect the atmosphere as well as the land. The methodology utilized in this study has been designed to translate intangible pollutional concepts into measurable terms and to develop facts where only conjecture existed heretofore.

Specific factors of public area sanitation that have, or could have, a bearing on the conversion of land and air pollution into water pollution factors include:

- Street litter debris which can be washed into sewer inlets, in bulk or in the form of washout of soluble constituents
- Debris washed into streets from vacant land or contiguous open urban areas into street gutters, and street or pavement surface material eroded or unravelled where it is subject to water-buoyancy or washout into street inlets to storm or combined sewers
- Salt or other ice control chemicals, and anti-skid traction materials, with or without corrosion inhibitors, which can be carried into sewers in suspended or dissolved form
- Chemicals used in public operations or by citizens to control pests, insects, weeds, and rodents, and as soil conditioners or fertilizers, which are then carried into sewer inlets by washoff from vegetation or land surfaces
- Droppings from animal or bird sources which are deposited on streets and contiguous land, lawns, parkways or buildings
- Lawn and garden litter and other vegetation wastes including deciduous leaves
- Remnants of household or commercial refuse which are strewn into streets by the action of winds, animals, or collection crews
- Air deposited substances which originate as particulates or gaseous emissions from stacks and which are dissolved by precipitation or washed out in dissolved or suspended form after they have been deposited on urban land surfaces, and
- Direct discharges of waste waters from such operations as air scrubbing which convert air polluting ingredients into water polluting substances without utilizing the so-called "aerial sewer" as the connecting link to street sewer inlets.

Many public-works practices result in concurrent reduction of pollution from storm water. However, this has not been necessarily the primary consideration in developing current procedures. For instance, air pollution control devices are being installed on municipal incinerators, and ordinances are being passed and enforced to reduce air pollution. These acts are designed to improve air quality. However, they also play a role in reducing storm-water pollution. In like manner, municipalities have traditionally swept public streets to remove litter and improve the aesthetic conditions of neighborhoods, as well as to reduce public safety hazards from fire, clogging of drainage facilities, and impediments to traffic. As revealed by this study, street cleaning also reduces the pollution potential of drainage runoff.

It now becomes apparent that a new dimension must be added to measurement of the effectiveness of public works services, namely the reduction or control of storm-water pollution.

Study Rationale

There are several basic methods by which a governmental agency may reduce pollution of storm waters. Obviously, if the agency could require the cooperation of each individual in preventing the polluting of the environment, storm water would flow to the drainage facilities with minimal exposure to pollution-causing material. This is an over-simplification of the problem inasmuch as there are many types of material with which storm water will come in contact and which are not directly controllable by any individual.

There are many ordinances, rules, and regulations which, if enforced, could be effective in controlling pollution, particularly in streets and public ways where storm water is readily polluted. Such requirements include the control of open-area erosion, littering prohibitions, regulating sidewalk sweeping, stipulating refuse storage and handling methods, and stipulating methods for handling construction materials.

Any program to reduce storm-water pollution in a relatively efficient manner requires public cooperation. Keep America Beautiful, Inc. and local beautification and "clean-city" organizations have done much in past years to promote anti-littering activities. Prevention of storm-water pollution adds further justification for the activities of many of these citizens groups.

Public participation in litter-control efforts places further burden on public officials to improve existing community sanitation programs and initiate others. Improved public works practices would include:

1. Greater care in refuse collection to prevent spillage of materials on streets or impervious areas
2. Improved catch basin cleaning methods
3. Installation of additional litter baskets at appropriate locations, and
4. More frequent and effective street cleaning.

If public-works agencies are to succeed in controlling storm-water pollution, they must rely on new or improved sanitation practices. Some, which readily suggest themselves are:

- Vacuum sweeping of streets
- More frequent sweeping of streets, with additional dust and dirt control as an objective
- The possible elimination of catch basins on combined sewers
- Initiation of scheduled periodic sewer flushing or other sewer cleaning procedures
- Banning street parking, and

- Improved construction, operation, and maintenance of combined-sewer regulators.

The APWA in its report entitled "Problems of Combined Sewer Facilities and Overflows—1967," estimated on the basis of the information available that it would cost approximately $15 billion for the facilities needed for treating combined-sewer overflows. While no estimates have been made of the cost to treat storm-water discharges, it can be assumed that this would be significantly greater inasmuch as the peak flows would require high hydraulic capacities for handling dilute liquids, thus making treatment more expensive. The emphasis for this study, therefore, was on evaluating the causes of runoff pollution and the practices which might avert or alleviate pollution.

Setting for the Study

The extent of storm water as a significant, albeit sporadic source of pollution of receiving bodies of water has been recognized only within recent years. Palmer(1) sampled storm-water runoff from land surfaces at street catch basins in downtown Detroit in 1949. He found Biochemical Oxygen Demands (BOD) on the order of 96 to 234 mg/1; total solids, 310 to 914 mg/1; and coliform ranges of 25,000 to 930,000/100 ml. He also reported similar samplings during a number of Detroit storms in 1960.(2) These 1960 studies revealed that the mean suspended solids for a number of samples from two storms were 213 and 102 mg/1, respectively. The coliform levels for four storms ranged from 2,300 to 430,000. Concentrations varied widely between points and at the same point during runoff. To quote Palmer: "In some cases the quality of the material became worse as the storm progressed and in others it became better, and in still others no pattern was apparent."

In 1954, a study of surface runoff from a 611-acre (248-hectare*) estate with separate sewers at Oxney, England, (3) showed BOD's up to 100 mg/1 and suspended solids contents up to 2,045 mg/1. BOD's tended to increase with the length of the antecedent dry-weather period up to eight to ten days; after that little further change developed. Computations were made to compare discharges to the river from the separate system with a hypothetical combined system wherein all flow would receive treatment. On the basis of assumed treatment plant effluent levels of 20 mg/1 for BOD and 30 mg/1 for suspended solids, it was concluded that the separate system reduced the BOD loading on the stream, but increased the suspended solids loading by six or seven times. First flushes were not much more polluting than subsequent flows, except after long antecedent dry periods.

A translation of a report on the results of a sampling study of storm-water runoff in Moscow, U.S.S.R., in 1936, indicated BOD's of 186 to 285 mg/1, and suspended solids of 1,000 to 3,500 mg/. Runoff samples from

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Note*: 1 hectare (ha) = 2.47 acres

Leningrad's cobblestone paved streets in 1948-50 contained BOD's of 36 mg/l and suspended solids of 14,541 mg/l.(4)

Storm-water samples from Seattle street gutters, in a study made by Sylvester in 1959 and 1960,(5) contained constituent values as follows: turbidities, up to 1,290 units; color, to 350 units; BOD's with aerated Green Lake water as the diluent, about 10 mg/l; coliforms, to 16,100 MPN's/100 ml. Nutrient values were: organic nitrogen, up to 9.0 mg/l; nitrate nitrogen, to 2.80 mg/l; and phosphorus, to 784 mg/l soluble, and to 1,400 mg/l total, as P. The highest constituent concentrations usually were found when antecedent rainfall had been low.

Summer rainwater drainage samples mainly from streets and parks in Stockholm, Sweden, from 1945 to 1948,(6) indicated median values for coliforms at 4,000/100 ml; COD, 188 mg/l; total solids, 300 mg/l; fixed residue, 210 mg/l; and BOD, 17 mg/l. The levels for individual samples ranged as high as 200,000/100 ml for coliforms; 3,100 mg/l COD; 3,000 mg/l total solids; 2,420 mg/l fixed residue; and 80 mg/l BOD.

Storm-water samples from residential, park, school, and sports ground type areas in Pretoria, South Africa,(7) revealed coliform counts of 240,000/100 ml; total organic nitrogen, 5.4 mg/l; COD, 29 mg/l; dissolved solids, 228 mg/l; and BOD, 30 mg/l. From a business and flat area, the concentrations were: coliforms, 230,000/100 ml; total organic nitrogen, 3.5 mg/l; COD, 28 mg/l; dissolved solids, 154 mg/l; and BOD, 34 mg/l.

Study of storm-water runoff from a 27-acre (11 ha) residential and light-commercial urban area in Cincinnati, Ohio,(8) reported in 1966, indicated the following constituent averages: suspended solids, 227 mg/l; volatile suspended solids, 57 mg/l; COD, 111 mg/l; BOD, 17 mg/l; inorganic nitrogen, 1.0 mg/l; total hydrolyzable phosphate, 1.1 mg/l; and organic chlorine, 1.7 mg/l. Some or all of these could be of significance, depending on the environment. Constituent loads in the urban runoff, calculated both on an annual basis and on the basis of daily discharges during storms, and compared with sanitary sewage production at a nine-person/acre (22 person/ha) population in the runoff equal 160 percent of those produced as sanitary sewage; COD, 33 percent; BOD, seven percent; total hydrolyzable phosphate, five percent; and total nitrogen, 14 percent. During runoff, storm water runoff constituent discharge rates, expressed as percentages of average raw sewage constituent production rates at the same population density mentioned above are suspended solids, 2,400 percent; COD, 520 percent; BOD, 110 percent; total hydrolyzable phosphate, 70 percent; and total nitrogen, 200 percent. Coliform densities were greater than 2,900/100 ml in 90 percent of the samples and exceeds the standard for swimming water quality in use in many places in the United States.

Table 1, Characteristics of Storm-Water Runoff, presents the information from the various studies that have been made in order that the magnitude of the pollution of storm-water runoff may be compared with ordinary sanitary sewage and drinking water. Storm-water runoff has been found in many instances to be akin to sanitary sewage in its pollutional characteristics and in a few instances some parameters of pollution are even greater.

Because of the increasing needs for conservation and effective use of all available water resources, urban-storm water may plav an important role as a readily available raw-water resource. Studies that have been made indicate that in many cases storm water will require modification in character before it is acceptable for the varied beneficial uses to which it can be put.

The interception of storm-water runoff, its impoundment in leaching basins, and its use to supplement ground water resources, such as now practiced in Nassau and Suffolk Counties, Long Island, N.Y., indicates the potential value of such waste waters for reuse purposes. It emphasizes the need to protect runoff waters against preventable urban pollution from land and air sources.

Public Health Service publication No. 1246, "Pollutional Effects of Storm Water and Overflows from Combined Sewers Systems," appraised the extent of combined sewer overflows and pollution from storm-water discharges. Reports from 39 municipalities were examined and the preliminary interpretation was made that storm water and combined sewer overflows are responsible for major amounts of polluting material in the nation's receiving waters. Increased urbanization will increase discharges which adversely affect most water uses in receiving watercourses. Thus, the PHS recommended that a comprehensive study should be initiated to expand on the preliminary study and explore, in depth, causes and control of storm-water pollution. The subject project and this report thereon satisfies, at least in part, the Number 1 recommendation of the PHS study in that it provides further understanding of many of the factors influencing pollution of storm water and furnishes guides for future methods of control.

TABLE 1. Characteristics of Storm Water
(Other Studies)

City	BOD mg/l	Total Solids mg/l	Suspended Solids mg/l	Coliform /l	Chlorides mg/l	COD mg/l
1. East Bay Sanitary District						
Minimum	3	726	16	4	300	
Maximum	7,700		4,400	70,000	10,260	
Average	87	1,401	613	11,800	5,100	
2. Cincinnati, Ohio						
Maximum Seasonal Means	12	260				110
Average	17		227			111
3. Los Angeles County						
Average 1962-63	161	2,909			199	
4. Washington, D. C. Catch-basin samples during storm						
Minimum	6		26		11	
Maximum	625		36,250		160	
Average	126		2,100		42	
5. Seattle, Washington	10			16,100		
6. Oxney, England	100**	2,045				
7. Moscow, U.S.S.R.	186-285	1,000-3,500**				
8. Leningrad, U.S.S.R.	36	14,541				
9. Stockholm, Sweden	17-80	30-8,000		40-200,000		18-3,100
10. Pretoria, South Africa						
Residential	30			240,000		29
Business	34			230,000		28
11. Detroit, Michigan	96-234	310-914	102-213***	930,000**		
Criteria* for:						
A. Potable water						
(to be filtered)				5,000	600**	10
(not to be filtered)				50		10
B. Body contact water				2,400	NA	

*New York State

**Max.

***Mean

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2. **Palmer, C. L.** "Feasibility of Combined Sewer System." *Journal Water Pollution Control Federation.* 35, 2, 162. Feb. 1963.

3. **Wilkinson, R.** "The Quality of Rainfall Run-Off Water From A Housing Estate." *Jour. Inst. Pub. Health Eng.* (Brit.). London. 1962.

4. **Shigorin, G. G.** "The Problem of City Surface Run-Off Water." *Vodosnabzhenie i Sanitarnaya Tekhnika.* 2, 19. 1956.

5. **Sylvester, R. O.** "An Engineering and Ecological Study for the Rehabilitation of Green Lake." University of Washington. Seattle, Washington. 1960.

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8. **Weibel, S. R., Anderson, R. J.,** and **Woodward, R. L.** "Urban Land Runoff as a Factor in Stream Pollution." *Journal Water Pollution Control Federation.* 36, 7, 914. July, 1964.

Section 4

Sources of solids causing surface pollution of a unit area in the city of Chicago

Interdependencies exist among the many environmental factors which have an effect on water pollution including air pollution dustfall levels, street sweeping loadings, refuse collection quantities, catch basin solids, sewer solids, and sewage treatment plant influent and effluent characteristics. The pertinent question is how important are these interactions and how can existing practices be modified to achieve optimal programs for air, water, and land quality management? The following preliminary evaluation is based on a literature review and contact with the appropriate public agencies in the Metropolitan Chicago area. It serves as a data preamble to the actual studies carried out on environmental wastes and their pollution impact on runoff water.

The purpose of this analysis was to explore the relative importance of the sources of urban solids that create potential storm water runoff pollution. A preliminary quantification of the magnitude of the various solids sources is presented.

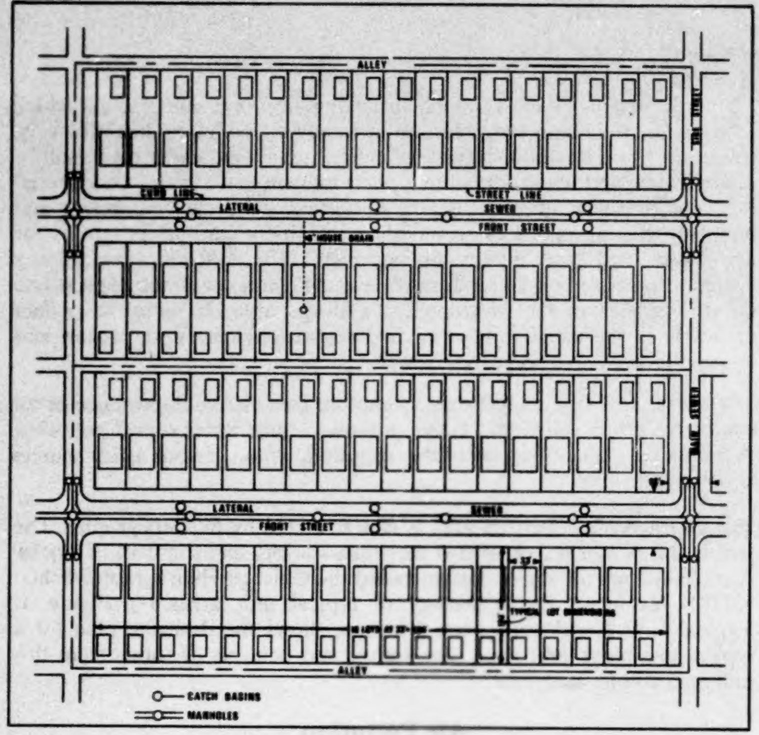
The Chicago Metropolitan area is characterized by flat topography. The streets follow a grid pattern that partitions the city into a system of blocks. A methodology for sewer design, called the Chicago Hydrograph Method (CHM), evaluates the hydrology of typical unit areas. ([1]) Figure 1, Typical Unit Residential Area, Chicago, shows the drainage plan for a typical two-block unit area. The source and controls of solids from this unit area will be analyzed.

Air Pollution

Dustfall from air pollution is a source of solids that can be characterized. During 1966, the average annual dustfall loading in Chicago was 36.9 tons per square mile per month as compared with a corresponding average of 41.0 tons in 1965. ([2]) These dustfalls levels are significantly less than the levels that prevailed a decade earlier when the average loading during the period from 1954 to 1965 was 54.9 tons per square mile per month.

The dustfall particulates range from 20 to 40 microns in diameter. The chemical composition of dustfall is described in an article by Johnson et. al. ([3]) For the purposes of this report it is sufficient to categorize dustfall as "fines" relative to other solid wastes.

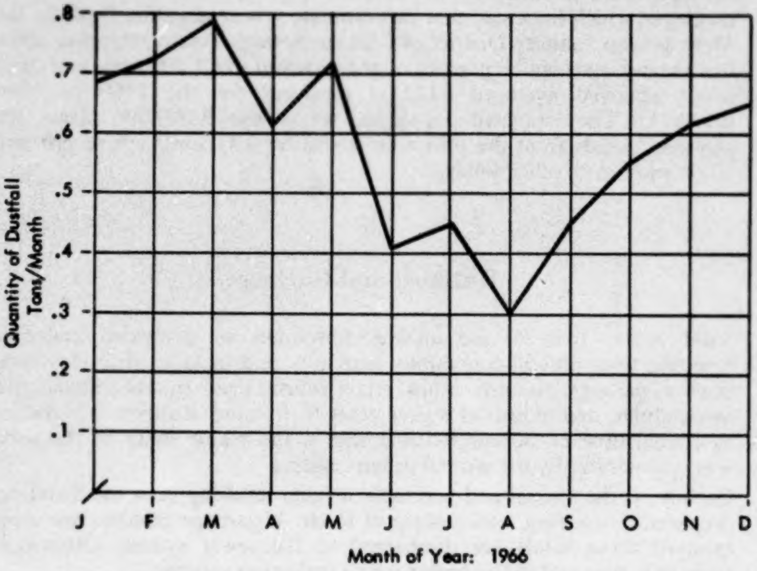
FIGURE 1. **Typical Unit Residential Area, Chicago**


ALLEY
SIDE STREET
CURB LINE
STREET LINE
LATERAL
SEWER
FRONT STREET
6" HOUSE DRAIN
SIDE STREET
LATERAL
SEWER
FRONT STREET
25'
TYPICAL LOT DIMENSIONS
18 LOTS AT 25'= 450'
ALLEY
CATCH BASINS
MANHOLES

The expanse of the unit area is 10 acres (4 ha) which is equivalent to 0.0157 square miles. Consequently, the quantity of dustfall settling on this unit area would average 0.58 tons per month for 1966 conditions. The seasonal distribution of dustfall loadings on this unit area, presented in Figure 2, 1966 Monthly Dustfall Loadings on Unit Area Chicago, demonstrates the commonly observed heavier loadings in the winter months.

Analysis of the spatial distribution of dustfall levels in Chicago reveals a range from 20.6 to 61.4 tons per square mile per month at the 20 stations during 1966. With this many sampling stations it is possible to make relatively good estimates of dustfall levels on any given area of the city.

FIGURE 2. 1966 Monthly Dustfall Loadings on Unit Area, Chicago



Sanitary Wastes

For the purpose of this section, sanitary wastes are defined as household liquid wastes, with the exception of garbage, which are discharged to the public sewer system. Since no direct data were available regarding sanitary wastes alone it was necessary to rely on published estimates. Fair and Geyer estimated the average per capita solids in domestic sewage to be 250 grams per capita per day. (4) This estimate is further partitioned into two components: 90 grams of suspended solids and 160 grams of dissolved solids.

There are 72 single-unit dwellings in the study area. The average number of persons per family is 3.9 for the City of Chicago. Based on these data, the estimated total solids load from this source is 2.4 tons per month for the unit area. For this evaluation it will be assumed that this estimated monthly load remains constant over the year.

An alternative method of estimating the quantity of sanitary wastes was employed which indicated that this estimate was reasonable. Data for the Metropolitan Sanitary District of Chicago Sewage Treatment plants show that the average annual quantity of grit removed was 7,200 tons, and other solids removed averaged 312,000 tons/year for the 1960 to 1966 period. (6) The estimated population served was 5,000,000. Thus, the pro-rated solids from the unit area would be 0.41 tons/year of grit and 17.6 tons/year of other solids.

Rubbish and Garbage

Solid wastes refer to the unused, unwanted, or discarded materials resulting from normal community activities, and includes such classifications as garbage, rubbish, ashes, street refuse, dead animals, abandoned automobiles, and industrial wastes other than liquid. Rubbish is classified as combustible or noncombustible and is the major share of the solid wastes generated by the normal urban resident.

Garbage is the animal and vegetable residue resulting from the handling, preparation, cooking, and serving of foods. If garbage grinders are used, most of these solids are discharged to the sewer system. Otherwise, garbage is removed via orthodox refuse collection services.

Because refuse-collection records ordinarily do not provide a breakdown of the total quantity of solid wastes by types, it was necessary to use several sources of information as a basis for the estimate.

The results of an APWA questionnaire survey of 85 cities in 1955 indicated a median quantity of 148 pounds of garbage/capita/year with a range of 74 to 263 pounds. (7) With regard to the effect of garbage grinders, the average annual garbage collection in Los Angeles was 129 lb/capita as compared to 210 lb/capita in Washington, D.C. (7) It was concluded that this large disparity is primarily attributable to the difference in the use of garbage grinders in the two cities: one grinder unit for each eight persons in Los Angeles as compared with one for every 50 persons in Washington, D.C.

Based on these data, the expected annual amount of garbage, in the absence of garbage grinders, is 16 lb./capita/month, or approximately one-half lb./capita/day.

Significant seasonal variations in the quantity of garbage have been observed. The availability of relatively abundant amounts of fresh vegetables and fruits at lower prices in the summer months causes an increase in garbage production during this period. (7) There has also been a significant decrease in the portion of refuse that is attributable to garbage over the past 10 or 20 years due to the growing popularity of frozen, packaged, and ready-prepared food. It will be assumed that the portion of garbage loading relative to the average is as follows: 75 percent in winter, 100 percent in spring and fall, and 125 percent in summer.

The annual quantity of total household refuse is estimated to be 715 lb./capita/year (7) or about 2/lb./capita/day. This amount considers only *refuse from a residential area* in contrast to the four to 4.5 lb./capita/day for total refuse which includes commercial and industrial refuse.

Based on the above assumptions, the estimated monthly quantity of garbage and total refuse is tabulated for the unit area in Table 2, Monthly Distribution of Garbage and Household Refuse, From A 10-Acre (4 ha) Residential Area, Chicago. This reveals that of the 100.2 tons per year of refuse from the unit area, 27.6 tons, or 27 percent, is garbage.

TABLE 2. Monthly Distribution of Garbage and Household Refuse, from a 10-acre (4 ha) Residential Area, Chicago

Month	Garbage (Tons/Month)	Total Household Refuse* (Tons/Month)
Jan.	1.8	7.2
Feb.	1.8	6.8
March	2.3	7.9
April	2.3	8.8
May	2.3	8.5
June	2.8	9.2
July	2.8	8.7
Aug.	2.8	9.3
Sept.	2.3	8.9
Oct.	2.3	8.3
Nov.	2.3	8.4
Dec.	1.8	8.2
TOTAL	27.6	100.2

*Includes garbage.

Unclassified Solids Sources

Finally, miscellaneous solids accumulate in the street gutters and elsewhere and must be removed. The magnitude of this solids category was estimated using street-sweeping and catch basin cleaning data. It should be noted that a portion of the street sweepings can be attributed to air pollution dustfall.

The average volume of solids collected by mechanical street sweepers in the City of Chicago was 28.8 cu. yd./curb mile/year for the 1964-1966 period.(8)

There are 0.688 curb miles in the unit area and the average quantity of street sweepings removed from the unit area is estimated to be 19.7 cubic yards. Analysis of the seasonal distribution of street sweepings indicates a surprisingly uniform pattern. Figure 3, Seasonal Pattern of Sweeping Loadings, Chicago, shows the monthly distribution of sweepings for the months when the sweepers are in operation. Examination of the figure reveals three distinct seasons: (1) the spring-cleaning period during which the winter residue plus the spring loading must be removed, (2) the summer period with a constant buildup rate, and (3) a heavier loading in the fall due to the leaves.

Preliminary analysis of data for the 50 wards in Chicago revealed a relatively small variance from the average city-wide sweeping loadings with the exception of October, the month with the heaviest sweeper loading. Data regarding tree density for various areas of the city were unavailable. It could be hypothesized that population density would vary indirectly with tree density in established residential areas of the city. Figure 4, Variations in Street Sweeping Loadings for a High and Low Population Density Ward in Comparison with the Average City-wide Loading, Chicago, illustrates the variation in sweepings for a high and low population density ward, in comparison with the entire city. Only in October when leaves are heaviest is there a significant difference in the amount of street sweepings per curb mile.

Based on Figure 3, it will be assumed that a base loading of 1.5 cu. yd./curb-mile prevails in the unit area. The results of a study of street sweepings in Chicago provides a breakdown of components. Table 3, Average Components of Street Sweepings from Residential Areas, shows the breakdown for general residential areas.

TABLE 3. Average Components of Street Sweepings from Residential Areas, Chicago, June 19 to August 29, 1967

(By Weight)

Item	Rags	Paper	Dust & Dirt	Vegetation	Inorganic
% Wgt.	0.2	4.7	72.0	11.1	12.0

FIGURE 3. Seasonal Pattern of Sweeping Loadings, Chicago

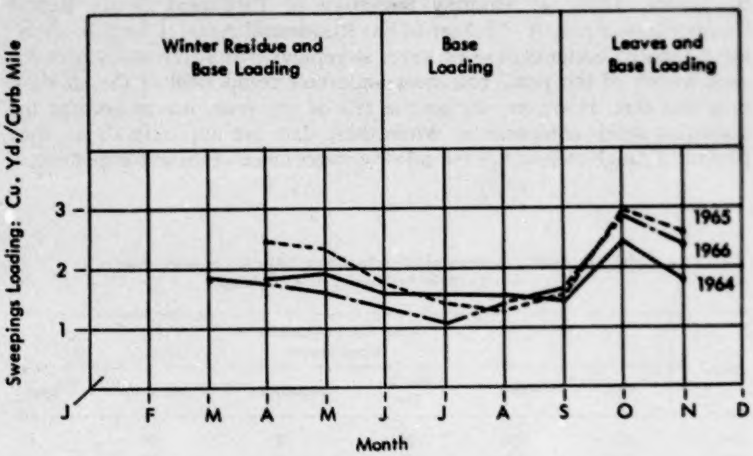
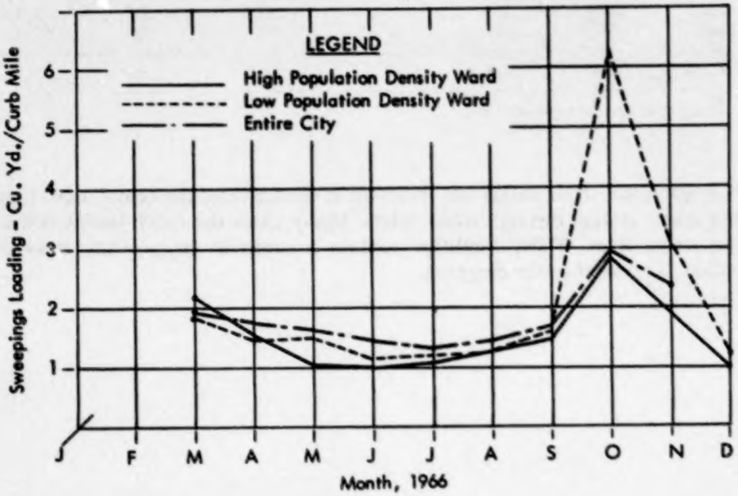


FIGURE 4. Variation in Street Sweeping Loadings for a High and Low Population Density Wards in Comparison with the Average City-wide Loading, Chicago



It will be assumed that this breakdown is representative of street sweepings for December through September. The heavier loading in October and November, relative to other months, is assumed to be caused by leaves. Table 4, Monthly Summary of Estimated Street Refuse Components, From A 10-Acre (4 ha) Residential Area, Chicago, shows the estimated accumulation of street sweepings within the study area for each month of the year. The most important component of the solids is dust and dirt. However, during the fall of the year, leaves become the dominant solids components. While these data are approximations, they provide a rough measure of the relative importance of these components.

TABLE 4. Monthly Summary of Estimated Street Litter Components, from a 10-acre (4 ha) Residential Area, Chicago

Month	Street Refuse Components (Tons/Month)					
	Rags	Paper	Dust & Dirt	Vegetation	Inorganic	Total*
Jan.	.0015	.036	.55	.00	.09	.68
Feb.	.0015	.036	.55	.00	.09	.68
March	.0015	.036	.55	.08	.09	.76
April	.0015	.036	.55	.08	.09	.76
May	.0015	.036	.55	.08	.09	.76
June	.0015	.036	.55	.08	.09	.76
July	.0015	.036	.55	.08	.09	.76
Aug.	.0015	.036	.55	.08	.09	.76
Sept.	.0015	.036	.55	.08	.09	.76
Oct.	.0015	.036	.55	.83	.09	1.56
Nov.	.0015	.036	.55	.83	.09	1.56
Dec.	.0015	.036	.55	.00	.09	.68
TOTAL*	.0180	.432	6.60	2.22	1.08	10.48

*Some totals have been rounded off.

Not all of the street solids are removed at the surface; the remainder enter the sewer system through street inlets. Many cities use catch basins below the street inlet. These facilities contain a sump to capture the heavier solids to prevent sewer clogging.

There are 20 catch basins within the unit area, with an estimated annual solids removal of .87 cu. yd./catch basin/year.(9) Using a density of 0.3 ton/cu. yd.* the quantity of solids removed from the unit area is 5.2 tons/year. Analysis of monthly data regarding catch basin cleaning revealed no discernible seasonal variation. This result was expected since the catch basins were cleaned an average of two and one-half times per year during the 1959 to 1960 period.(9) Consequently, the catch basin solids represent an aggregate over a period of four to six months. Little information is available regarding the individual constituents of catch basin solids. However, it appears that the material is composed of some of the components of street sweepings.

Summary of Identifiable Solids Sources

A summary of the solids sources discussed is presented in Table 5, Estimated Monthly Quantity of Identifiable Solids From Typical 10-Acre (4ha) Residential Area, Chicago. For the unit area, approximately 179 tons per year of solids will be generated—air pollution dustfall contributes 2.9 percent; domestic sanitary wastes, 16.1 percent; garbage, 15.4 percent; rubbish, 56 percent; street sweepings, 5.7 percent; and catch basins, 2.9 percent. Public sewers can remove no more than 20 percent (sanitary wastes and ground garbage). At least part of the remaining 80 percent, if not promptly removed or stored, can add to storm-water pollution.

The magnitude of the component sources has been estimated in order to provide a preliminary appraisal of their individual importance in the overall problem of solid-wastes management. Previous studies of water pollution have focused on the effluent of the system, using the given observed pollutional load at the outfall of the sewer system to determine the optimal (least cost, in this situation) combination of pollution control facilities in order to meet a specified water quality management objective.

This investigation has examined the influent end of the sewer system in an attempt to identify the community wastes which are created and must be collected and disposed. If the scope of the analysis is restricted to minimization of water pollution, without regard to air and land pollution, then it would be desirable to minimize the quantity of solids entering the sewer system. This could be achieved by forbidding the discharge of food wastes into combined sewer systems, increased programs of street sweepings to eliminate all waste contacts with runoff waters and other stringent alternatives. However, the desirability of pursuing such alternatives is dependent not only on water quality management objectives but also on factors of public service and convenience, community cleanliness, health and safety, and air and land quality management objectives within the urban area.

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*The estimated density of catch basin solids is 0.5 tons/cu. yd. However, much of this is water so that a figure of 0.3 tons/cu. yd. of actual solids was used.

TABLE 5. Estimated Monthly Quantity of Identifiable Solids from a Typical 10-acre (4 ha) Residential Area, Chicago, Illinois

Quantity of Solids Sources (Tons/Month)

Month	Air Pollution Dustfall	Domestic Sanitary Wastes	Household Refuse		Exterior Solids		Total**
			Garbage	Rubbish	Street* Sweepings	Catch Basins	
Jan.	0.68	2.4	1.8	7.2	0.68	.43	13.2
Feb.	0.78	2.4	1.8	6.8	0.68	.43	12.9
March	0.80	2.4	2.3	7.9	0.76	.43	14.6
April	0.60	2.4	2.3	8.8	0.76	.43	15.3
May	0.72	2.4	2.3	8.5	0.76	.43	15.1
June	0.40	2.4	2.8	9.2	0.76	.43	16.0
July	0.46	2.4	2.8	8.7	0.76	.43	15.6
Aug.	0.30	2.4	2.8	9.3	0.76	.43	16.0
Sept.	0.45	2.4	2.3	8.9	0.76	.43	15.3
Oct.	0.56	2.4	2.3	8.3	1.56	.43	15.5
Nov.	0.61	2.4	2.3	8.4	1.56	.43	15.6
Dec.	0.66	2.4	1.8	8.2	0.68	.43	14.2
Total**	7.00	28.8	27.6	100.2	10.50	5.20	179.3

*Solids in litter baskets are not included, as litter baskets are not used in general residential areas.

**Totals are rounded.

The purpose of the above discussion is to point out the fact that control of urban storm water runoff must be consistent with the long-range objective of determining the optimal waste management program by giving simultaneous consideration to the land, air, and water resources of the area.

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Section 5

Sources and Amounts of Storm Water Runoff Pollution

Pollution of rainfall (storm water) may occur in three general zones: (1) the sky, (2) on the ground and man-made structures, and (3) in the storm drainage system. Pollution occurs in the atmosphere from rainout or washout of the local atmosphere. Once the precipitation has reached the surface it may be intercepted by impervious areas. Precipitation on previous areas from small storms does not produce immediate runoff and thus may be disregarded as a matter of general concern. Precipitation falling on impervious areas will runoff rather quickly during the course of which it dissolves or washouts any polluting material with which it comes in contact.

Runoff reaching the drainage system may be further polluted by contact with debris in a catch basin or, in the case of combined sewers, by mixing with sewage or industrial waste with resuspended solids previously shoaled. Although some portion of storm-water flow in a combined sewer generally goes to the waste water treatment facility, excessive amounts are diverted to the nearest waterway because of lack of capacity in interceptor sewers or at the treatment plant. Sometimes diversions occur before sewer capacity is exceeded because of maladjustment or malfunctioning of overflow regulator devices.

Street Refuse

Street refuse or litter is defined as the accumulation of materials found on the street, sidewalk, or along the curb and gutter which can be removed by sweeping. All components of street litter contribute to water pollution, in the form of floating material, suspended or dissolved solids, and by bacterial contamination. The amount and composition of street litter varies widely. However, no systematic effort previously has been made to determine its rate of accumulation and composition over a period of time.

The sources of street litter vary from community to community, from season to season, and from area to area of the same community. Street litter is the product of both human and natural actions. Litter (which is defined as waste scattered about—a clutter), includes remnants resulting from careless public and private waste collection operations; animal and bird fecal droppings; soil washed or eroded from land surfaces; construction debris; road surfacing materials ravelled by travel, impact, frost action or other causes; air pollution dustfall; wind-blown dirt from open areas; and a host of subsidary materials.

An examination of these sources indicates practical approaches to their elimination or reduction by such practices as:

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- Inducing better cleanliness practices on the part of the public
- Instituting better waste collection practices—relating to types of storage receptacles for refuse in homes and commercial establishments, types of collection vehicles and methods of handling material by collectors
- Reducing conditions that are the cause of soil washout or erosion, and
- Regulating aerial emissions from commercial, industrial and residential stacks.

The composition of litter is varied, depending upon density of population, habits of residents, number of vehicles and pedestrians, intensity of street use, the nature of abutting property, and seasonal and climatic conditions. This study has relied on specified areas of the City of Chicago for test and study purposes. The data on the nature of litter components and their amounts give an insight into the solids with which precipitation runoff comes in contact under various urban conditions.

Data contained in this section of the report provide information on:

- Amount of litter accumulation in the areas chosen as test sites for the project studies
- Relationship between amounts of litter and the specific land use patterns of each test area
- Components of street litter and variations in composition for the various test areas
- Correlations between amounts of litter, frequency of precipitation, and litter depositions, and
- Frequency of street cleaning operations and methods used in those operations for the Chicago test areas and for other American cities.

Field Studies

In the summer of 1967, during the period from June 19 to August 29, field tests on streets were conducted in 18 Chicago areas. Areas for conducting the studies were chosen to represent a varying range of urban-land uses.

Table 6, Characteristics of Street Refuse Test Areas—Summer, 1967—Chicago, summarizes certain characteristics of the 18 test areas. The areas can be categorized as representative of three business, two industrial, and four residential zoned groupings. The overall length of the area swept represents the distance from the building line at one end of the area to the building line at the other end. The width of the intersecting sidewalks and street (measured parallel with the gutter) at the intersection were not swept and are not included in the data. Also computed, in Table 6, is the blockfrontage of buildings and open areas. This was done to indicate possible sources of washout during rainstorms. Note that test Areas 11 and 12 were discontinued early in the test and data is not reported here.

The quantity and character of street litter may vary considerably from day to day during a weekly period, as well as from season to season. In congested shopping areas, large quantities of litter would be expected during shopping days but little when stores are closed. During the fall, leaves may be a major street cleaning problem in some areas. Another factor influencing the quantity of street litter is traffic—both pedestrian and vehicular.

Table 6A, Pedestrian and Vehicle Counts at Spaced One-Hour Intervals for Street Refuse Test Areas—August, 1967, gives a sampling of one-hour pedestrian and vehicular counts in 14 of the 18 areas. Business streets show peak pedestrian volumes during the going-to-work, luch-hour, and going-home periods. Litter from pedestrians tends to reflect such peaks. Vehicles also tend to produce litter in proportion to traffic volume. Additional descriptions of the test areas are given in Appendix A.

Generally a four-man crew was used to obtain the street litter samples and from two to four men were used to sort the samples for analysis. Initially, a small vacuum type sidewalk sweeper was used to obtain the samples. However, experience revealed that the rough and varying types of material in the street prevented the vacuum device from accomplishing full removal. Therefore, most samples were obtained by hand sweeping of the gutter area, using standard street-type brooms.

Test areas were swept on a varying schedule, depending upon the anticipated amount of litter, presence of parked vehicles, and crew time available. Tests were started at 5:30 A.M. each weekday and concluded by 1 P.M. One area (No. 3) characterized by large volumes of pedestrian traffic adjacent to a transfer point between city buslines and rapid-rail transit was swept twice a day. Two other commercial (No. 1 & 2) and one industrial area (No. 4) were swept daily. Other areas were swept biweekly or weekly.

Where rain, standing water, or parked vehicles hampered access to the curb area, the area was not swept. Areas swept weekly were posted for no parking on the day prior to sweeping. Samples which were damp upon receipt were warmed by a heater to drive off excess moisture and then air-dried in sunlight to three-to-five-percent moisture.

The samples were initially weighed and then sorted into the following categories: paper, glass, metal, plastics, rock and inorganic, organic including food, vegetation, wood (diameter in excess of one inch), cloth, and dust and dirt. Dust and dirt was specified as solids passing a 1/8-inch hardware cloth. Efforts were made to minimize the adhesion of dust and dirt to the larger components.

Test sections were generally 300 feet or greater in length. Close attention was given to determine whether or not adjacent residents would take advantage of the tests by placing additional material in the streets for pickup. This did not occur, although a few store owners were observed to sweep their sidewalk debris into the street. During the tests, there was no construction activity in the immediate area, except in Area 1 where the curb and gutter section was replaced by city forces. During the period of this construction, field tests were discontinued. No other unusual conditions were noted.

TABLE 6. Characteristics of Street Refuse Test Areas, Summer, 1967, Chicago

					Property Frontage on Test Streets									
					Residential		Commercial		Industrial					
Test Area	Street From—To	Zoning	Over-all Length Feet*	Half-Width of Street Feet	Bldgs.	Families	Bldgs.	Stores	Bldgs.	Businesses	Street Frontage of Bldgs. Feet	Non-Bldg. Frontage Feet	Percent Frontage Built on	Percent Frontage not Built on
1	N/S 63rd St. from Ellis to Ingleside	B3-3	382	24.5	-	-	8	16	-	-	382	0	100	0
2	E/S Stony Island from 68th to 69th	B5-3	583	32	3	76	9	25	2	2	583	0	100	0
3	West half-intersection of 63rd & Stony Island	B4-3	344(b)	22; 24.5(a)	-	-	5	11	-	-	344	0	100	0
4	S/S South Chicago Ave. from Clyde to Jeffrey	MI-2	600	36(c)	-	-	1	1	1	1	350	250	42	58
5	W/S East End Ave. from 91st Pl. to 92nd Pl.	R-2	538	13	3	4	-	-	-	-	n/a			
6	N/S 81st St. from Bennett to Jeffrey	R-2	538	14	4	4	-	-	-	-	276	262	51.4	48.6
7	E/S Blackstone & S/S E. 61st from E. 60th to Dorchester	R-5	775	14.5 17.5(d)	2	14	2	11	1	1	650	125	84	16
8	E/S Kenwood Ave. from 60th to 61st St.	R-5	576	24	3	37	1	1	2	2	445	131	77.2	22.8

9	N/S Marquette from Blackstone to Stony Island	R-5	594	16.5	10	62	1	1	-	-	455	139	76.7	23.3
10	N/S Marquette from Minerva to Greenwood	R-4	520	16.5	6	98	-	-	-	-	492	28	94.6	5.4
13	Federal from 53rd to 51st St.	R-4	1,139	21	3	n/a	-	-	-	-	705	434	62	38
14	W/S Dearborn from Garfield to 54th St.	R-4	581	15	16	56	-	-	-	-	392	189	67.5	32.5
15	N/S 51st St. from St. Lawrence to Cottage Grove	R-5	990	18	15	262	2	3	1	1	980	10	99	1
16	E/S Woodlawn from 48th to 49th St.	R-1	587	16.3	7	7	-	-	-	-	355	232	60.5	39.5
17	S/S 48th St. from Woodlawn to Kenwood	R-1	727	18	6	6	-	-	-	-	380	347	52.3	47.7
18	E/S Jeffrey from 89th to 91st St.	R-2	585	19.3	32	32	-	-	-	-	420	165	71.8	28.2
19	W/S Union Ave. from Pershing Rd. to 41st St.	M2-3	1,062	19.3	-	-	-	-	4	2	561	501	52.8	47.2
20	E/S Kimbark from 60th to 61st St.	R-2	610	15	3	61	-	-	1	1	439	171	72	28

*Bldg. line at end of area to bldg. line at other end--ignoring sidewalk widths and intersections

NOTES -
(a) First no. for 63rd St. and second for Stony Island
(b) Includes both sides of 63rd St., also unusual concentration of birds
(c) From divider to curb; concentration of garbage cans at one location
(d) First number for Blackstone, and second for E. 61st St., also construction activity in area.
Unusual concentration of dogs on south side Marquette; refreshment stand along test curb.

TABLE 6A: Pedestrian and Vehicle Counts at Spaced One-hour Intervals for Street Refuse Test Areas - August, 1967

Test Area	Zoning	Type	Date	Day	6AM-7AM	9AM-10AM	12N-1PM	3PM-4PM	6PM-7PM	9PM-10PM	12AM-1AM
1	B3-3	Pedest.	8/30	Wed.	99	315	279	215	230	-	-
		Auto.	--	-	529	375	552	691	454	-	-
		Pedest.	8/31	Thur.	335	253	-	-	405	-	-
		Auto.	--	-	456	393	-	-	642	-	-
		Pedest.	9/1	Fri.	242	397	440	452	530	137	-
		Auto.	--	-	563	491	535	550	481	501	-
2	B5-3	Pedest.	8/30	Wed.	-	104	151	134	-	-	-
		Auto.	--	-	-	1,271	1,543	1,775	-	-	-
		Pedest.	/31	Thur.	24	-	-	-	-	-	-
		Auto.	--	-	1,100	-	-	-	-	-	-
3	B4-3	Pedest.	8/30	Wed.	565	292	233	440	-	-	73
		Auto.	--	-	775	452	395	870	-	680	210
		Pedest.	8/31	Thur.	-	325	300	460	-	-	-
		Auto.	--	-	-	540	485	662	-	-	-
6	R-2	Pedest.	8/31	Thur.	-	128	-	155	189	275	184
		Auto.	--	-	-	433	-	480	595	876	610
		Pedest.	9/1	Fri.	-	76	153	134	247	258	-
		Auto.	--	-	-	398	476	511	465	600	-
7	R-5	Pedest.	8/31	Thur.	-	42	62	-	-	-	-
		Auto.	--	-	-	41	52	-	-	-	-
		Pedest.	9/11	Fri.	11	-	-	-	-	-	-
		Auto.	--	-	30	-	-	-	-	-	-
8	R-5	Pedest.	9/1	Fri.	-	21	43	-	-	-	-
		Auto.	--	-	-	149	145	-	-	-	-
10	R-4	Pedest.	8/31	Thur.	-	49	51	69	-	-	-
		Auto.	--	-	-	389	289	529	-	-	-
		Pedest.	9/1	Fri.	-	-	-	-	-	-	-
		Auto.	--	-	-	-	-	-	-	-	-

13	R-4	Pedest.	8/30	Wed.	-	25	43	33	-	-	-
		Auto.	--	-	-	76	88	98	-	-	-
		Pedest.	8/31	Thur.	18	-	-	-	-	-	-
		Auto.	--	-	79	-	-	-	-	-	-
14	R-4	Pedest.	8/31	Thur.	-	20	29	-	-	-	-
		Auto.	--	-	-	9	18	-	-	-	-
		Pedest.	9/1	Fri.	10	-	-	66	-	-	-
		Auto.	--	-	13	-	-	25	-	-	-
15	R-5	Pedest.	8/30	Wed.	-	44	63	67	-	-	-
		Auto.	--	-	-	437	505	594	-	-	-
		Pedest.	8/31	Thur.	53	-	-	-	-	-	-
		Auto.	--	-	299	-	-	-	-	-	-
16	R-1	Pedest.	8/31	Thur.	-	6	2	-	-	-	-
		Auto.	--	-	-	239	222	-	-	-	-
		Pedest.	9/1	Fri.	1	-	-	12	-	-	-
		Auto.	--	-	120	-	-	222	-	-	-
17	R-1	Pedest.	8/31	Thur.	-	2	1	-	-	-	-
		Auto.	--	-	-	46	54	-	-	-	-
		Pedest.	9/1	Fri.	1	-	-	15	-	-	-
		Auto.	--	-	18	-	-	47	-	-	-
18	R-2	Pedest.	8/30	Wed.	-	8	18	12	-	-	-
		Auto.	--	-	-	571	746	974	-	-	-
		Pedest.	8/31	Thur.	6	-	-	-	-	-	-
		Auto	--	-	496	-	-	-	-	-	-
20	R-5	Pedest.	8/31	Thur.	-	8	15	17	-	-	-
		Auto.	--	-	-	74	96	106	-	-	-

The summer of 1967 was unusually rainy. This offered ample opportunity to determine the affect of precipitation on the accumulation of street litter. Rainfall data are presented in Appendix B, Table B-1. Total rainfall is given for the Chicago Woodlawn Station, which was close to the test areas. The time when rainfall occurred, however, was not available for Woodlawn and is given for Midway, a distance of eight miles from the center of the test area.

The data gathered in the 18 test areas were divided into two categories (1) those not affected by rain, and (2) those where rain had occurred between successive sweepings. As previously mentioned, the component of the street litter which passed through the hardware cloth was classified as "dust and dirt" (D/D). It was this component which was considered to have the greatest pollution-causing effect. To reduce various cleaning frequencies and gutter lengths to a common unit of measurement, "pounds per day per 100 feet of gutter (or curb) swept" was used. For the areas which were swept less frequently, such a unit tends to smooth out daily fluctuations as compared with data obtained for an area which is swept daily. Sweepings from the initial cleaning were not considered since it established an initial "Clean" condition for the subsequent sweepings.

The material retained on the hardware cloth was sorted out into nine other categories, as shown in detail in Table 7, Summary of Street Litter Components—for Areas 1, 2 and 4.

Nine areas that were similiar to many of the 18 hand swept areas were selected for machine cleaning to provide further data. Thus it was possible to analyze substantially longer gutter lengths with machine sweeping.

Findings

Dust and Dirt

Table 8, Summary of Amount of Dust and Dirt Component, tabulates the data in terms of Unaffected by Rain, Affected by Rain, and Disregarding Rain. It might have been expected that frequent rainfall would tend to diminish the quantity of dust and dirt component on the street, due to hydraulic washaway. However, this was not the case. There was a tendency for the rain-affected results to show higher values than the non-rain-affected data, for the dust and dirt which was air-dried before weighing. The rains tended to increase the quantity of hand-swept dust and dirt rather than to decrease it. An examination of the 18 areas in Table 8 shows that in nine of the areas there were none, or only one sample, in the non-rain-affected category. These are disregarded because of insufficient number of samples. For the other nine test areas, each had at least five rain-affected and non-rain-affected samples. Six of the averages of the rain-affected samples show greater weights of dust and dirt components than their counterpart non-rain-affected samples.

An attempt was made to correlate the increased amounts from the rain-affected samples with the frontage data presented in Table 6 on the

TABLE 7. Summary of Street Litter Components (For Areas 1-2-4--lb./day/100 ft)

Component	Unaffected by Rain a)					Affected by Rain b)					Disregarding Rain c)				
	No. of Samples	Max.	Min.	Average	Median	No. of Samples	Max.	Min.	Average	Median	No. of Samples	Max.	Min.	Average	Median
Area 1															
Dust & Dirt	25	9.40	.55	2.73	2.45	13	4.53	.55	2.11	2.04	38	9.40	.55	2.53	2.24
Glass	27	.940	.008	.193	.152	15	.398	.004	.129	.087	42	.940	.004	.170	.147
Paper	30	1.93	.04	.51	.42	13	2.34	.15	.70	.47	43	2.34	.04	.57	.44
Metal	27	.431	.008	.100	.080	14	.320	.039	.093	.079	41	.431	.008	.097	.080
Plastics	18	.112	.008	.002	.016	12	.048	.004	.016	.009	30	.112	.004	.019	.014
Rock and Organics	28	15.457	.100	1.331	.326	15	1.813	.162	.459	.289	43	15.457	.100	.867	.289
Organics	23	.073	.004	.028	.016	12	.200	.004	.040	.020	35	.200	.004	.032	.016
Vegetation	2	.156	.017	.087	.087	1	.066	.066	.066	.066	3	.156	.017	.080	.056
Wood	24	.151	.008	.038	.018	13	.175	.009	.040	.022	37	.175	.008	.039	.020
Cloth	9	.083	.008	.037	.017	6	.224	.012	.072	.038	15	.224	.008	.051	.028
Area 2															
Dust & Dirt	29	25.08	.44	7.00	5.22	16	16.33	.78	4.72	3.32	45	25.08	.44	6.19	4.65
Glass	29	.621	.005	.167	.134	14	.636	.012	.173	.138	43	.636	.005	.169	.134
Paper	29	2.655	.020	1.045	.652	16	1.143	.109	.474	.419	45	2.655	.020	.674	.587
Metal	27	.659	.017	.130	.096	16	.336	.006	.096	.070	43	.659	.006	.117	.087
Plastics	24	.030	.005	.012	.010	13	.099	.002	.018	.011	37	.099	.002	.014	.010
Rock and Organics	29	4.311	.036	1.046	.783	16	1.218	.041	.429	.290	45	4.311	.036	.827	.617
Organics	23	.070	.005	.024	.017	11	.046	.003	.016	.012	34	.070	.003	.021	.017
Vegetation	7	.258	.017	.068	.029	2	.041	.005	.023	.023	9	.258	.005	.058	.029
Wood	23	.365	.003	.046	.020	12	.149	.003	.031	.015	35	.365	.003	.041	.020
Cloth	20	.136	.005	.039	.024	11	.113	.003	.033	.021	31	.136	.003	.037	.023
Area 4															
Dust & Dirt	29	24.28	.58	3.60	1.61	17	52.63	1.18	8.76	2.88	46	52.63	.58	5.37	2.11
Glass	12	.133	.001	.030	.009	8	.105	.004	.033	.016	20	.133	.001	.031	.012
Paper	28	.47	.03	.15	.12	18	2.74	.02	.44	.22	46	2.74	.02	.26	.13
Metal	22	.125	.004	.032	.023	16	.173	.004	.028	.015	38	.173	.004	.030	.018
Plastics	12	.017	.003	.006	.005	9	.011	.001	.004	.003	21	.017	.001	.005	.004
Rocks and Organics	28	2.578	.125	.422	.285	17	4.905	.052	.711	.226	45	4.905	.052	.531	.251
Organics	10	.131	.001	.033	.008	8	.050	.002	.009	.004	18	.131	.001	.022	.055
Vegetation	27	.305	.004	.028	.015	16	.499	.005	.066	.020	43	.499	.004	.042	.018
Wood	7	.076	.001	.028	.027	6	.162	.002	.058	.036	13	.162	.001	.042	.027
Cloth	9	.052	.001	.021	.020	6	.022	.002	.011	.009	15	.052	.001	.017	.013

a) No rain between cleaning events

b) Rain between cleaning events

c) Total in both groups

TABLE 8. Summary of Amount of Dust and Dirt Component (lb/day/100 ft)

Area	Zoning	Unaffected by Rain					Affected by Rain					Disregarding Rain				
		No. of Samples	Max.	Min.	Avg.	Median	No. of Samples	Max.	Min.	Avg.	Median	No. of Samples	Max.	Min.	Avg.	Median
	BUS.															
1	B 3-3	25	9.40	.55	2.73	2.45	13	4.53	.55	2.11	2.04	38	9.40	.55	2.53	2.24
3	B 4-3	27	3.58	.45	1.52	1.36	16	4.96	.02	1.81	1.41	43	4.96	.02	1.88	1.35
2	B 5-3	29	25.08	.44	7.00	5.22	16	16.33	.78	4.72	3.32	45	25.08	.44	6.19	4.65
	IND.															
4	M 1-2	29	24.28	.58	3.60	1.61	17	52.63	1.18	8.76	2.88	46	52.63	.58	5.37	2.11
19	M 2-3	1	7.16	7.16	7.16	7.16	8	24.02	3.55	10.53	9.96	9	24.02	3.55	10.16	7.85
	RES.															
16	R-1	0	-	-	-	-	8	1.89	.04	.36	.17	8	1.89	.04	.36	.17
17	R-1	1	.06	.06	.06	.06	7	1.91	.05	.42	.21	8	1.91	.05	.37	.20
5	R-2	5	.29	.03	.14	.12	12	1.14	.05	.46	.32	17	1.14	.03	.36	.18
6	R-2	7	1.19	.34	.59	.51	11	1.95	.21	.62	.33	18	1.95	.21	.61	.45
18	R-2	1	.44	.44	.44	.44	8	7.41	.31	2.00	.97	9	7.41	.31	1.82	.69
10	R-4	7	1.06	.21	.70	.72	13	2.97	.86	1.44	1.14	20	2.97	.21	1.18	1.06
13	R-4	1	16.94	16.94	16.94	16.94	7	58.27	3.59	17.09	6.52	8	58.27	3.59	17.07	9.00
14	R-4	1	1.98	1.98	1.98	1.98	8	5.16	1.08	2.62	2.25	9	5.16	1.08	2.55	2.00
7	R-5	5	4.48	.92	2.70	2.98	11	5.42	.47	2.12	1.58	16	5.42	.47	2.30	1.60
8	R-5	0	-	-	-	-	6	1.64	.27	.67	.53	6	1.64	.27	.67	.53
9	R-5	5	.72	.43	.60	.64	13	5.74	.49	1.90	.99	18	5.74	.43	1.54	.77
15	R-5	0	-	-	-	-	7	5.53	.19	2.80	2.58	7	5.53	.19	2.90	2.58
20	R-5	0	-	-	-	-	9	7.59	.90	2.90	1.92	9	7.59	.90	2.90	1.92

hypothesis that dirt washouts from adjacent areas were occurring. However, no consistent correlation was found. Field checks were made of the areas to see if there were identifiable sources of the dirt such as washouts from yards and unpaved driveways. The field observations failed to indicate the specific sources of the additional material, although some of it may have been washed onto the streets from passing motor vehicles and the remainder from adjacent pervious and impervious areas.

Other Components

Table 7, summary of Street Litter Components, tabulates data for three test areas. A comparison of the average weight of street refuse components for the Unaffected by Rain vs. Affected by Rain street sweeping occurrences excluding dust and dirt shows a definite tendency for the Affected by Rain amounts to be generally lower. In Area 1, only organics (food, animal droppings), wood, and cloth were heavier in the rain-affected category. In Area 2, only rain-affected glass and plastics were heavier. In Area 4, rain-affected glass, rock and inorganics, vegetation, and wood components were greater. It is also apparent that the dust and dirt fraction was the higher component in all three areas. Figure 5, Average Components of Street Litter, presents in graphical form the relative amounts of the major portion of the street litter collected during the entire testing period by weight. In all but low density residential areas, dust and dirt was the major component.

Control Areas

Table 9, Control Area Data-Machine Swept, summarizes the data gathered in the longer machine-swept areas: these were cleaned at intervals of seven to fourteen days. In general, the weight/day/hundred feet of curb of the dust and dirt fraction fell within, or close to, the ranges shown in Table 8 in the "ignoring rain" columns. Since there were only a few samples taken in each of the nine control areas, the data are presented in chronological order and not computed fully into ranges, averages, and medians, or divided into rain-affected and non-rain-affected categories.

Conclusions

Dust and Dirt

A major conclusion is that the amount of rain may be ignored in the dust and dirt fraction. This seems to be true regardless of sweeping frequency, since Area 3 was swept twice daily, and yet showed higher values after rain than without rain in a business area that was 100 percent built-up and

FIGURE 5 Average Components of Street Litter, Chicago

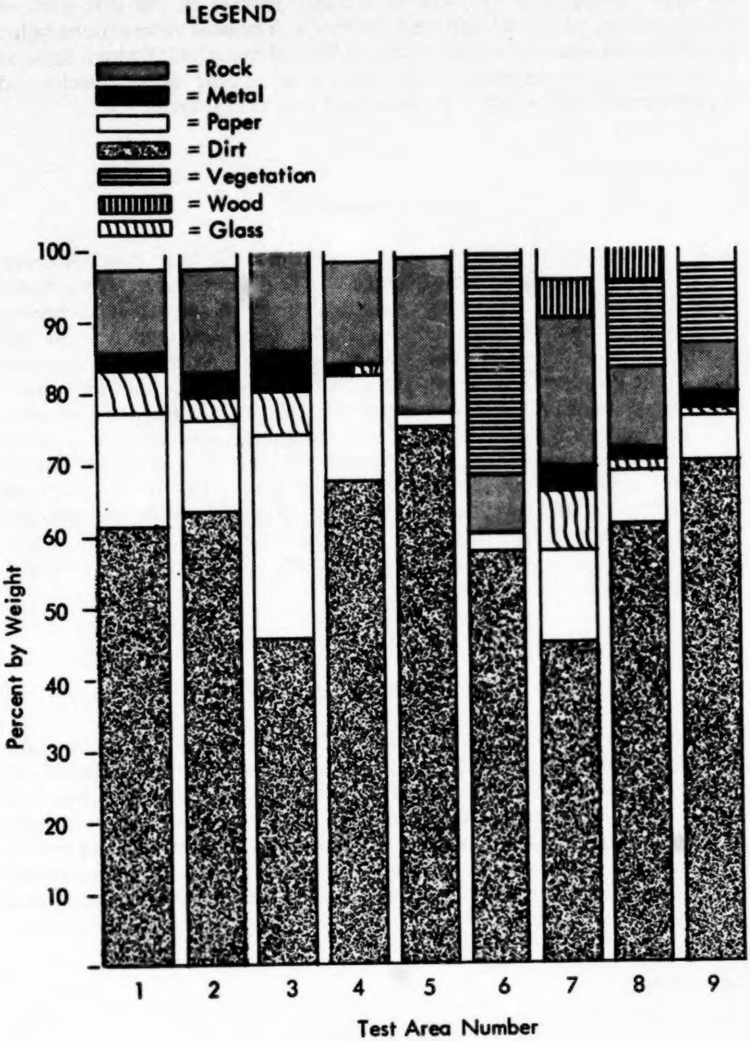


FIGURE 5 (Cont.) Average Components of Street Litter, Chicago

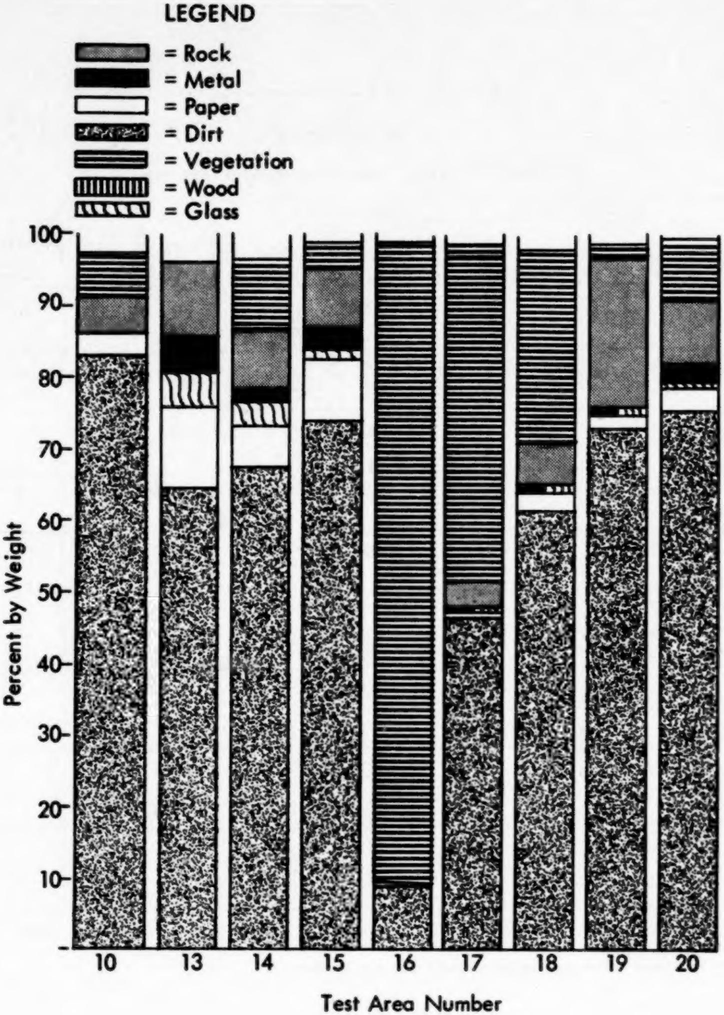


TABLE 9. Control Area Data-machine Swept

(7-14 Day Intervals)

(All areas machine swept two weeks prior to first date shown)

CONTROL AREAS			Machine Swept Length, Ft.	Dates Swept	Dust and Dirt lb/day/100 ft	
No.	Similar* To These Test Areas	Description**			In Chronological Sequence	Average
1	5,17	88 - 91 Cregier-Euclid	8,925	7/5, 7/12, 7/20, 8/3	.60- .41- 1.22- -.44	.67
2	5, 6, 17	84 - 85 Phillips-Escanaba	8,325	7/5, 7/12, 7/20, 8/3	1.09-1.66- .32- -.38	.86
3	9, 16	68 - 70 Merrill-Oglesby	6,300	7/5, 7/12, 7/20, 8/3	3.84-1.95-1.20- .47	1.86
4	6	67 - 70 Bennett-Euclid	7,125	7/5, 7/12, 7/20, 8/3	.52-.35-.18- .25	.32
5	7, 8, 10, 20	71 - 74 Kimbark-Blackstone	9,050	7/20 8/3	4.30 1.43	-
6	7, 8, 10, 20	64 - 66 Eberhart-Evans	10,150	7/19 8/2 8/16	2.22 .26 .45	-
7	8, 9, 10, 15	61 - 62 Drexel-Dorchester	8,920	7/19 8/2 8/16	4.11 1.07 1.93	
8	15, 20	56 - 58 Woodlawn-Blackstone	6,175	8/2 7/5 8/16	1.04 .67 .33	
9	15,20	52 - 54 Berkeley-Woodlawn	6,375	8/2 7/5 8/16	.45 .86 .31	

* Similarity judged by land use characteristics and visual assessment of amount of street litter.

** Each area encompasses approximately nine city blocks.

with a minimum potential for earth washout from upland areas. Industrial areas tended to provide maximum street litter and this may be related to washout. Commercial areas tend to generate a somewhat lesser quantity of dust and dirt than industrial areas, but higher than residential areas. The residential areas tend to show increasing amounts of dust and dirt as the population density increases, this, no doubt, reflects the increasing usage made of the streets by pedestrians and vehicles. The unusually heavy sweeping for Area 13 reflects the high values of the initial three sweepings and may be disregarded as not typical.

Other Components

Organics (food, animal droppings) and vegetation could affect BOD readings but the amounts of such material were generally substantially less than amounts of dust and dirt. Paper, wood, and cloth were likewise small quantitatively, but are of interest because of their potential for "esthetic pollution." The other components are of interest because of potential deposition in sewers and watercourses but were small in weight, except for relatively heavy amounts of rock and inorganics.

Control Areas

The data from the nine areas generated from machine swept long gutter areas substantiates, in general, the more extensive findings in the shorter hand-swept areas.

In summary:

- For purposes of classification of the amount of street litter generated, the areas studied can be considered in three categories: (a) intense commercial and low-income high-density areas, (b) single-family moderate to high-income areas, (c) all other areas
- Total average street litter hand-swept in the 18 test areas for the 10-week study period in 1967 ranged from 0.5 pounds to 8 lb/100 ft of curb/day
- The average amount of street refuse for the test areas was 2.4 lb/day/100 ft of curb for single family residential areas, 3.5 lb/day/100 ft of curb for multiple family areas, and 4.7 lb/day/100 ft of curb for commercial areas
- The total dust and dirt fraction (-⅛ in.) of the street litter varied from 45 to 83 percent of the total litter. The amount of this dust and dirt fraction varied from 0.4 pound to 5.2 lb/day/100 ft of curb and
- The average amount of dust and dirt was 0.7 lb/day/100 ft of curb for single family residential areas, 2.3 lb/day/100 ft of curb for multiple family areas, and 3.3 lb/day/100 ft of curb for commercial areas.

Pollution Potential of Street Litter

The study of the test areas defined the amounts and composition of the street litter. However, it was not possible to capture the runoff water itself and, by analysis, define the amounts of pollution carried by the runoff during all or parts of storms of varying length and intensity. In lieu of such test data, information on other studies of the quality of runoff water was reported in Section III.

In the absence of specific information on the effects of washout and washaway on street debris, the study approached the problem of translating the waterwastes contacts into water pollution terms on the basis of *maximum potential pollution* effect of certain litter components on runoff waters and the effect of those polluted runoff-borne flows on receiving waters.

What actually happens to street litter varies with so many factors that no single evaluation of actual pollution potential is representative of all conditions which might occur in practice. The variable factors include:

- Street litter can be removed from a street area before any precipation occurs and runoff water comes in contact with it, in which case and under ideal conditions no significant pollutional effect would result. This is a theoretical assumption because street sweeping operations are never successful in removing *all* dust and dirt from the surface even though gross debris may be removed by mechanical or hand operations
- During periods of no precipitation and runoff, some litter can enter a street inlet by various means and be retained in the catch-basin area until it is washed, scoured, or dissolved by subsequent runoff
- During a runoff period, some or all of the street litter can be carried into a sewer inlet in dissolved form or even be water-buoyed, depending on the amount, duration, and intensity of the storm runoff, and
- By water classification, the lighter components can be washed into a street inlet and the heavier materials can remain stranded in the gutter line—the actual nature of material classification will vary under different combinations of circumstances, including intensity of precipitation, runoff, and gradient of the street.

For the purpose of translating street litter into pollution potential, certain assumptions were made:

- All litter that can accumulate between sweepings will be on the street at the time of the precipitation and runoff incident
- The major constituent in the street litter that can produce pollution in the runoff water is the dust and dirt fraction—solids which are minus 1/8 inch in size
- Only the soluble material will produce chemical and bacteriological pollution

- All the soluble material will be dissolved out or washed out by the runoff water and become pollution
- The BOD of the dissolved washout material can be used as the most tangible measure of the "pollution equivalent" caused by street litter
- Thus, the *maximum pollution potential,* in terms of BOD, is assumed to be produced by the washout of *all* soluble material in *all* the dust and dirt of all the street litter that will accumulate during a two-week period without any runoff incidents during the interim period, and
- The *maximum peak pollution flush* into receiving waters will occur when all soluble contaminants in such a two-week accumulation are washed out within or during a single two-hour runoff period.

Computation of Pollution Potential of Litter

The analytical procedures used to determine the pollutional components of street litter involved the following steps:

1. Collection of litter by hand-sweeping specific lengths of curb line in 18 test areas, as described elsewhere in this report
2. Examination of total litter for the purpose of ascertaining the various constituents of the debris and the percentages of such items as dust and dirt, paper, glass, metal, wood, vegetation, and rock
3. Analyses of composite representative samples of dust and dirt from the 18 test areas by the Pollution Control Laboratory, Chicago, to ascertain the amounts of contaminants in this material, in terms of mg/g of dry weight, including: water soluble material; volatile water soluble; phosphates as PO_4; 5-day BOD; COD; moisture and volatile content of the litter material; nitrogen as N; ammonia nitrogen as N; nitrate nitrogen as N; total bacteria plate counts per gram of dust and dirt; confirmed coliform, MPN/g; and fecal enterococci/g.
4. Determination of the specific gravity of fractions of the dust and dirt retained on screens of USS sizes 10, 16, 20, 30, and
5. Analyses of samples of swept leaves for 20-day BOD and COD on the basis of "as received" condition.

The methods of preparing samples for the analyses and the analytical procedures used (based on the A.P.H.A. Standard Methods for the Examination of Water and Sewerage) are described in the following excerpts of a memorandum prepared by the Pollution Control Laboratory, the commercial laboratory which performed the laboratory analysis for this study.

July 6, 1967

Collection of Samples

Samples are to be collected by the personnel of the American Public Works Association from an area roughly bounded by 39th Street, the Dan Ryan Expressway, 92nd Street and Lake Michigan. They will represent materials "wasted" to the street and gutters by the populace living under several different social-economic conditions in the area.

Type of Samples

Samples consist of materials passing through a 1/8-inch hardware cloth.

Analytical Procedures

(a) A portion of the material passing the 1/8-inch sieve will be pulverized to pass a 40-mesh screen. A weighed amount of the pulverized material will be blended in a Waring blender with sterile, distilled water and made up to a definite, known volume with sterile distilled water. The blended sample will be divided into two portions.

Portion one will be filtered through No. 1 Whitman filter paper or its equivalent. Water soluble matter, volatile water soluble matter, nitrate, and phosphate will be determined on the filtrate using "Standard Methods." Content will be reported as milligram per liter in filtrate and milligram per gram in dry material.

Portion two will be analyzed for five-day BOD, 20-day BOD(a), COD bacteria plate count, coliform organisms (presumptive and confirmed), and enterococcus organisms (presumptive confirmed.)

Note: Equipment and water must be sterile for bacteriological tests. Tests will be made as described in "Standard Methods." Content will be reported in milligram per gram of dry material. Coliform bacteria will be expressed as MPN per gram of dry material.

(b) The material passing the 1/8-inch sieve will be screened into five sieve fractions and the specific gravity will be determined on each fractions and the specific gravity will be determined on each fraction. Specific gravity will be determined as described in ASTM D153-54 (1966). *Note:* Screen sizes used: 10, 16, 20 and 30.

Phosphate, nitrate, BOD, COD and water soluble matter will be reported in milligrams per gram of dry material. Bacterial content will be reported as MPN per gram of sample as received and per gram of dry material.

A tabular summary presentation of the analyses for each sampling station is included in Table 10, Summary of Laboratory Reports of Street Litter Components. A summary of averages for each of the 18 test areas is given for the following items: lb/day/100 ft of curb for total litter and the dust and dirt fraction, water soluble, volatile water soluble, PO_4, 5-day BOD, COD, plate counts, confirmed coliforms, and fecal enterococci. The actual amounts of street litter and the dust and dirt fraction for each test area are

---

(a) The 20-day BOD test was discontinued after the second set of samples as there was no significant increase over the 5-day BOD.

TABLE 10. Summary of Laboratory Reports of Street Litter Components

Test Area Number	Average Strength									
	lb./day/100' total refuse		lb./day/100' dust & dirt		"Water Sol."		"Vol. Water Sol."		Phosphate as PO_4	
	rank	lbs.	rank	lbs.	rank	mg/g	rank	mg/g	rank	mg/g
1	10	4.15	11	2.53	7	998	16	525	13	.038
2	17	8.05	17	6.19	15	847	12	479	7	.027
3	9	3.81	6	1.35	18	1907	18	1078	18	.142
4	15	5.80	16	5.37	9	536	4	253	8	.030
5	1	0.45	1	0.36	1	31	1	140	2	.020
6	3	1.20	4	0.61	14	808	13	498	15	.070
7	11	4.70	9	2.30	7	518	3	245	18	.142
8	4	1.50	14	2.81	4	458	6	276	4	.021
9	66	2.65	7	1.54	13	774	15	524	14	.063
10	5	1.60	5	1.18	10	580	10	358	8	.030
13	7	3.50	9	2.30	2	362	2	189	5	.024
14	13	4.85	12	2.55	12	704	14	520	16	.073
15	14	4.90	13	2.80	7	528	9	331	2	.020
16	16	6.80	1	0.36	6	494	8	306	5	.024
17	2	0.90	3	0.37	16	904	17	651	17	.109
18	7	3.50	8	1.82	5	484	7	279	8	.028
19	18	16.50	18	10.16	11	658	11	398	1	.014
20	12	4.80	15	2.90	3	432	5	267	8	.030

NOTE: Test areas 11 and 12 were not sampled

Cont.

TABLE 10. Summary of Laboratory Reports of Street Litter Components

	Average Strength											
Test Area Number	5 day BOD		COD				Coliform Organisms (Confirmed)		Fecal Enterococci (Confirmed)		Nitrogen as N	
	rank	mg/g dry wt.	rank	mg/g dry wt.	rank	Colonies /g dry wt.	rank	MPN/g dry wt.	rank	MPN/g dry wt.	rank	mg/g
1	14	505	6	267	15	23,209,000	16	3,456,922	15	955	9	480
2	12	403	5	248	1	2,163,400	3	576,170	4	32	1	323
3	18	1454	17	667	8	9,908,000	5	1,022,633	1	4	8	457
4	9	295	2	230	6	5,992,000	1	324,900	3	27	7	431
5	1	172	1	183	7	6,428,000	6	1,050,200	6	130	2	325
6	16	91	15	531	4	4,964,000	7	1,128,500	5	41	11	523
7	4	218	14	507	5	5,880,000	9	1,340,000	14	700	11	523
8	6	281	7	295	9	10,765,000	8	1,210,000	12	572	16	773
9	13	477	16	613	11	16,212,000	13	2,644,000	13	605	4	377
10	8	290	10	326	3	4,196,000	10	1,620,000	7	188	5	405
13	3	203	11	340	12	17,168,000	15	3,059,000	8	266	17	845
14	15	632	13	456	14	21,118,000	18	5,379,000	10	451	15	670
15	5	228	4	246	13	20,680,000	17	4,122,000	9	402	18	961
16	11	324	3	245	10	11,440,000	4	1,020,000	17	1211	14	525
17	17	943	18	728	17	29,720,000	14	2,970,000	18	1293	11	523
18	2	194	9	321	2	2,430,000	2	389,750	2	15	10	482
19	7	282	8	318	16	25,976,000	12	2,589,200	11	530	6	410
20	10	322	12	346	18	34,984,000	11	2,076,360	16	1013	3	356

shown in Appendix B, Table B-1. The reports of the laboratory analyses made on the dust and dirt samples is contained in Appendix B, Table B-3, Summary of Laboratory Reports on Street Refuse Components.

The following tabulation highlights the findings with respect to the average amount of soluble matter in the dust and dirt samples:

Amount of Pollutant by Type of Land Use

Item	Single Family	Multiple Family	Commercial
Water Soluble (mg/g)	6.0	5.6	12.4
Volatile Water Soluble (mg/g)	3.8	3.4	6.9
BOD (mg/g)	5.0	3.6	7.7
COD (mg/g)	40	40	39
PO_4 (mg/g)	.05	.05	.07
N (mg/g)	.48	.61	.41
Total plate counts/g (x 1000)	10,900	18,000	11,700
Confirmed coliform/g (x 1000)	1,300	2,700	1,700
Fecal enterococci/g	645	518	329

Computation of Pollution Potential of Street Litter

The following computations show the pollution potential of street litter, using the above average data for soluble BOD per gram of the dry dust and dirt fraction of the amounts of litter swept in the test areas.

Steps that can be used for any community areas and condition to determine the pollution effect of street litter are:

1. Determine the curb or gutter mileage for each category of zoning or land use
2. Determine the average pounds of dust and dirt (D/D)/unit of curb and street length (100 feet, 1,000 feet, mile) for the various types of zoning or landuse areas
3. Multiply the length of street in each category by appropriate average D/D accumulations for the different zoning or land use classifications
4. Determine the water-soluble portion of the D/D fraction, ascertain the BOD of this fraction, and compute the amount of BOD/day/unit of street length
5. Assume that this BOD of the soluble D/D is the actual pollution factor of the total street litter
6. Convert the D/D BOD potential into population equivalent on the basis of raw sanitary sewage BOD of 0.17 pound/day/person
7. On the basis that sewage will be treated to meet state and federal requirements, convert the D/D potential BOD into population equivalent of sewage treatment plant effluent, assuming 80 percent removal of BOD by some form of secondary treatment, i.e.—effluent will be 20 percent or 0.034 pound of BOD/day/capita, and
8. Compute the "peak shock" effect of litter BOD pollution on receiving water on the assumption that street litter will accumulate between periodic sweepings and that the total pollution potential of this

accumulation will be washed by storm runoff into sewers in a prescribed period of precipitation, (for example, 14-day intervals between sweepings and the washing out or solution of soluble BOD in the litter within a two-hour period).

The following computations show how these data and relationships were determined for the Chicago test areas:

Amount of Dust and Dirt and Strength of BOD by Land Use

Land Use	Amt. of D/D by land use lb/day/100 ft of curb	BOD of D/D mg/g
Commercial	3.3	7.7
Industrial	4.6	3
Multiple family	2.3	3.6
Single family residence	0.7	5
Assumed weighted average	1.5	5

Then:

Total street litter accumulation	0.5 to 8.0 lb/day/100 ft curb
Total D/D street litter accumulation	0.4 to 5.2 lb/day/100 ft curb
Average D/D in street litter	1.5 lb/day/100 ft curb
D/D soluble BOD	5 mg/dry D/D; or 5 lb/1,000 lb
D/D per mile of curb	1.5 × 52.8 = 80/lb/day
D/D per mile of street (2 curb miles)	80 × 2 = 160 lb/day
D/D BOD per mile of street	5 lb × 160/1,000 = 0.8 lb/day

D/D BOD population equivalent
0.8/0.17 = 5 persons/day/mile street

For 80 percent BOD removal in sewage treatment plants: (100/20)

D/D BOD equivalent of treated sewage effluent

$0.8/(0.17 \times \frac{100}{20}) = 25$ persons/day/mile of street—approx.

The Department of Transportation, Bureau of Public Roads, statistics on population densities in American cities of various sizes per mile of street length (as of 1961) give the following values:

Population Groups	Persons per Mile
0 to 4,999	128
5,000 to 9,999	233
10,000 to 24,999	302
25,000 to 49,999	371
50,000 to 99,999	379
100,000 and over	494

For Chicago, using 500 persons per mile, the D/D BOD equivalent would be: 5/500 = *1% of the raw sanitary sewage BOD potential of raw sewage*

For a community of 5,000 to 10,000 population, the potential—using the Chicago litter D/D data—would be as follows:

Raw Sewage BOD 0.17 × 233 persons/mile = 40 lb/day
D/D BOD 0.80 pounds/mile of street/day
D/D BOD equivalent 0.80/40 × 100 = 2 percent

Litter accumulations/day/mile for such a small community would be less than 1.5 lb/day/100 ft of each, since litter is a product of people. Thus, the D/D BOD equivalent for a smaller community than Chicago may hold to the one percent value, as computed above.

For New York City, a similiar theoretical computation might be:

Street mileage	6,000 miles
Population	8,000,000
Persons/mile of street	8,000,000/6,000 = 1,300/mile
Potential BOD of raw sewage	1,300 × 0.17 = 200 pounds/day/ mile street

Using Chicago litter data:

D/D BOD population equivalency 0.80/220 = 0.4%

However, the New York City litter accumulation may be higher than the 1.5 lb/day because of greater population densities (no data is available from New York City litter quantities) and, here again, the one percent factor may be found to apply.

This *one percent and five percent formula* expresses a rule-of-thumb evaluation of the D/D pollution potential, as compared to raw sewage and secondary effluent potentials, respectively. In the case of any community using combined sewers, the percentage effect of D/D BOD in relation to treatment plant effluent goes down markedly due to the greater effect of raw sewage which overflows with storm water during runoff periods. In short, the same climatic conditions that cause storm runoff pollution also cause sewage overflow pollution, even in cases where sanitary sewage is treated by secondary processes.

Note: Communities can compute the D/D BOD potential for their street litter on the basis of actual population densities per mile of street and litter accumulations by land use areas and street sweeping frequency as in the steps previously outlined. In the absence of such data for each community, it might be assumed that the litter BOD potential would vary somewhat in proportion to the population and the actual composition of litter D/D fraction. The one percent and five percent values are suggested merely as representing one set of urban conditions, for the purpose of providing a general guideline in estimating the potential pollution effect of street litter.

Peak-Flush Shock-Loading Effect of Dust and Dirt

The project included a survey on a national scale for the purpose of ascertaining street cleaning practices in representative communities. These survey data are included in a later portion of this section.

It is evident that the frequency of cleaning varies widely and that no specific data can be provided here to represent the potential peak-flush effect of street litter dust and dirt washout during periods of precipitation. In addition, the effect of rainfall on dust and dirt washout during interim periods of non-sweeping is not ascertainable under such varying conditions. (Note: Data for the test areas indicate minimal effects of precipitation on litter accumulations, as previously described.) If the potential BOD of the soluble dust and dirt fraction of street litter were discharged uniformly *each day* over the entire city, the one percent and five percent factors might be utilized to show the actual comparative pollutional effect—raw sewage or treated sewage effluents versus litter pollution—on receiving waters. (Note: Sewage BOD is not discharged uniformly throughout any 24-hour period. Sewage flow peak of 250 percent, more or less, of average daily flows occur, and night-hour flows may be only 50 percent, more or less, of the average daily flow. The BOD momentarily discharged may vary in more or less proportional amounts.) But street refuse BOD runoffs are *not* uniformly discharged. This study assumes that the potential litter BOD will continue to increase as the amount of litter on the street increases between sweepings, and that the soluble BOD will be washed out in mass amounts when actual runoff occurs, thus producing a *peak-flush phenomonon which can impose shock loadings on receiving waters.*

In order to determine the possible effect of such peak-flush conditions, this study has assumed that street sweeping is carried out on a 14-day interval basis and that all of the potential BOD in the accumulated street litter will be washed out by precipitation runoff within a two-hour period. The time period was chosen on the basis of local rainfall records which tended to indicate that for most precipitation events, a large portion of the total precipitation would occur in a two-hour period. For some precipitation events, the two-hour length might not be sufficient to adequately dissolve the soluble portion of the dust and dirt. For other events, because of rainfall intensity and other conditions, the soluble portion conceivably could be dissolved in a shorter period. Thus the two-hour period is suggested as an average figure. On the basis of the two-hour period, the shock loading effect of dust and dirt BOD would be:

> 0.08 lb of BOD/day/mile of street × 14 days = 11.2 lb of BOD washout in a two-hour period. This BOD would be discharged in two hours of runoff.
>
> The Chicago raw sewage BOD is 500 persons/mile × 0.17 lb/person = 85 lb/mile/day.
>
> For a two-hour period, the raw sewage BOD would be 85/12 = 7 lb. (Note: the two-hour BOD would vary with the time of day; it could be relatively low if the storm occurred during the early morning hours).
>
> Therefore, the street litter D/D BOD potential for the two-hour period would be 11.2 lb/7 lb or approximately *160 percent that of the raw sewage pollution potential.*

For Chicago treated sewage effluent, the street litter BOD potential would be:

> 160 × 100/20 = *800% greater than the treated sewage effluent*

While this is a theoretical computation of peak-flush conditions, which may never be produced under "average" conditions, it could occur under certain circumstances.

The calculations demonstrate that:

- The actual *overall* effect of the pollution potential of street litter as measured by the BOD of soluble dust and dirt fraction, is small—one percent of raw sewage and five percent of treated sewage effluent BOD
- The possible momentary peak-flush shock loading on receiving waters could be considerably higher—160 percent of the raw sewage pollution and 800 percent of the treated sewage effluent pollution from the assumed 14-day accumulation during the two-hour flush period, and
- This shock loading could produce major oxygen depletion or sag in the vicinity of storm water discharge points and in a wider area until dilution or displacement occur.

These percentage effects of street litter runoff, as compared with treated sewage effluent discharges could be markedly reduced by the pollution effect of combined sanitary sewage and storm water overflows in the case of combined sewers.

Other Pollution Potentials in Street Litter

The foregoing computations are limited to the pollution effects of the BOD constituent of the dust and dirt fraction of total street litter. They are based on:

- The theoretical washout of *all* BOD in the dust and dirt fraction of street refuse, a condition which admittedly may not occur, at least in the majority of precipitation incidents
- The so-called soluble portions of the dust and dirt, obtained in the laboratory by means of the production of a slurry in a laboratory mixer and the filtration of the admixture through No. 1 Whatman filter paper, thus resulting in a total washout of *all* solubles. (Admittedly some solids may have been "liquified" by blender-action and thus increasing, in minor amount, the "soluble" fraction of the dust and dirt), and
- The BOD values may have been less than actual, because of some possibility that any organics capable of "flash" oxidation may have been so oxidized by the aeration "whip" action in the mixing device used in preparing samples for analysis.

It is obvious that these "ideal" laboratory sample conditions cannot be reproduced in the street, and that the laboratory BOD values may have been greater than would be produced by street runoff conditions. However, it is equally obvious that street litter contains BOD-producing substances, other than the minus 1/8-inch material (D/D) used in the laboratory determinations. This would include dirt adhering to gross paper, glass, metal, rags, uncomminuted animal droppings, rocks, and organic material such as vegetation, cellulose materials and foodstuffs. These material were *not* washed in the laboratory to ascertain the "total" pollution effect of *total* street litter. All analyses were carried out on minus 1/8-inch solids.

There is no way, from the study data, to prove the validity of any assumption that the additional gross-material washout not included in the analytical findings would be equal to, less than, or greater than the "over-effect" of the laboratory procedures. However, the "minus" from such plus 1/8-inch solids would help more or less to cancel out any "plus" due to the higher-than-actual-street-effects produced in the laboratory.

Over and above the pollution potential resulting from dissolved BOD in the dust and dirt fraction of street refuse, this fraction contained other pollution components.

COD The analyses indicated that street litter dust and dirt COD was approximately ten times as high as the BOD. In terms of pollutional effect, the shock loading of this pollutional constituent must be considered

Other Pollutional Constituents In addition to the effect of BOD and COD loadings in receiving waters by street litter washout-runoff, the litter contained appreciable amounts of nitrogen in various forms: phosphates;

total bacteria; coliforms; and fecal enterococci organisms. These pollutional factors must also be considered in evaluating the effect of street refuse on receiving waters.

The following tabulation lists the average values of these constituents in Chicago raw sewage and treatment plant effluents, as compared with the street refuse dust and dirt contents assuming average per capita BOD of 0.17 lb/day.

These average figures are shown in terms of the amount of litter components in pounds/day/mile of street, and the comparable amounts of sewage and effluent components for 500 persons/day/mile of street.

Comparison of Sanitary Sewage and Street Litter Pollution Components

Item	Strength of Sanitary Sewage		Street[+] Litter/g	lb pollutants/mile[++]			
				Sanitary Sewage		Street Litter	
	raw	treated		raw	treated	1 day	14 days
BOD (ppm)	85	11	5,000	85	11	0.8	11.2
COD (ppm)	238	34.7	40,000	238	34.7	6.4	89.2
Phosphorous PO_4 (ppm)		13.5	50	-	13.5	0.008	.112
Total Nitrogen as N (ppm)	16.8	11.0	500[**]	16.8	11	0.08	1.12
Total coliform/ 100 ml	*	28×10^{4}	13×16^{6}	-	25×10^{8}	47×10^{10}	66×10^{11}
Fecal coliform/ 100 ml	*	16,000	540[**]	-	14×10^{7}	39×10^{5}	55×10^{6}

[*] not determined

[**] from dust and dirt fraction

[+] assumed weighted average

[++] assumed value of 1.5 lb/day/100 ft of curb

Suspended Solids Pollution It is evident that some coarse insoluble litter will be mechanically washed into street inlets and carried through sewer lines to points of discharge. These materials create visible pollution that may be relatively low in stream solids loading effects but of importance in terms of stream "aesthetics." These materials include: paper, fruit and vegetable remnants; vegetation and garden litter; and cloth and wood. (It is significant that state stream standards usually require absence of visible floating solids.) The decomposition of such material in catch basins, as discussed elsewhere in this report, adds to the adverse condition of floating and suspended substances and it may convert suspended solids into soluble forms by such decomposition. Odors from catch basins attest to the active putrefaction of decomposable materials stranded and retained in the basins.

These are the visible pollution components that the public associates with storm-water overflows. Casual observers know little or nothing about the BOD effect of soluble material because it does not litter the waters or shoal on shores in the vicinity of storm and combined sewer outlets. The public's support of water pollution control programs has resulted from the visual evidence of pollution.

Control of Street Litter

The control of street litter must begin at its source. Educational programs are needed to create a recognition among citizens of a community of the need for cleanliness in public and private areas and of the importance of such cleanliness to water pollution control. Traditionally, this has been accomplished by appealing to civic pride, stressing the cost to each individual of cleanup efforts, and defining the penalties of non-cooperation as set forth by local ordinances.

These efforts have had varying degrees of success. This has been attributed to the lack of individual incentive or reward, the lack of enforcement of existing ordinances, and the lack of adequate housekeeping efforts by the government jurisdiction itself. An adequate solid waste system is a basic community need. It is generally believed that litter left in the street tends to invite the deposition of more litter. Thus it is concluded that the presence of some of litter on the street reduces the incentive to refrain from further littering. This aspect of human reaction has often been described. It is significant that throughout the street litter sampling tests no clear evidence was found to support this contention.

Mr. Christopher Gilson, executive director, Citizens Committee to Keep New York City Clean, Inc., at the 1966 American Public Works Congress and Equipment Show stated that:

> "The hard facts are, however, that no city can afford any longer to stay dirty. There are three compelling reasons:
>
> 1. The cost of maintaining municipal services in run-down areas is is mounting because those areas are spreading as the result of deterioration that begins with dirt
> 2. The cost of physically replacing slums is skyrocketing beyond what even a combination of Federal and municipal governments conceivable can afford to pay. Thus the practical cure is to halt corrosion in the first place. The beginning point for that is to get rid of dirt
> 3. More and more industries are refusing to locate new plants in dirty towns. It doesn't require a calculator to figure out what a community loses in dollars and cents when it is passed over by a new industrial facility."

Thus, a jurisdiction must balance the cost of adequate street cleaning against the returns from reduced blight, improved sewer maintenance, less danger to moving vehicles and pedestrians, reduced storm water pollution, and increased economic development.

Public education, however, will not eliminate all street litter. Debris will still accumulate from air pollution fallout, animals, drippings from vehicles, and other sources.

Street Cleaning Methods

The usual method to keep streets clean is to sweep up the debris so that it can be economically loaded in a conveyance for removal to a disposal site.

Two types of sweepers have been developed: one utilizes mechanical pickup equipment and the second uses a vacuum system. Few American vacuum-type sweepers are produced for street use. Their use is limited to areas with flat surfaces and for cleaning in areas where there is little litter or as a followup after other cleaning to remove remaining small solids. Vacuum sweepers are also available for airports and in small models for sidewalk, warehouse, and parking lot use.

There are several manufacturers of sweepers using brooms for mechanical pickup. For many years, the principal machines in use by municipalities were three-wheel units with a capacity of three to four cubic yards. In recent years two manufacturers have developed four-wheel units, which incorporate a separate engine to drive the broom.

Generally, sweepers are equipped with a gutter broom. This is a circular device with steel strips, which is mounted on a controllable frame to dislodge material near the gutter and move the material across the front of the pickup broom. This device is necessary because at least 80 percent of the street litter is within 18 inches of the curb. The wind action and the effect of traffic move most material to this location. Where continuous curb-side parking is permitted, litter may accumulate across the entire parking lane.

In dislodging street litter which is dry and contains fine particles such as silt, the gutter broom creates dust. Therefore, sweepers incorporate a spray bar across the front of the machine to moisten the litter with sufficient water to minimize the dust nuisance.

Following the spreading of the litter by the gutter broom, a vertically revolving broom is used to flick the material from the street to a conveyor. There are many types of broom material. Natural fibers such as palmayra, bass, and hickory were popular for many years. Recently plastic and steel fibers have been used. These latter materials have been used with a variety of stiffness factors and cross sections.

Natural fibers are generally wound about a cable with a length of fiber 26-inches long bent in the middle to make a 13-inch broom length. When the fiber length from the core wears down to a length of six to seven inches, the broom is refilled with new fibers. Natural fiber brooms normally can be used to sweep 100 to 150 curb-miles. The newer fibers are available in a disc or coil pattern for placement on the broom. Sweeping service of 1,500 to 3,000 curb-miles has been reported for the newer fibers.(1)

Wear on the broom is largely governed by the type of surface to be swept, operator care in adjusting the broom, and the broom pattern—or width of broom in contact with the street surface.

Practice has shown that a four to six inch broom pattern is sufficient to remove street litter such as paper, cans, and most dirt and dust.

The frequency of street sweeping varies widely. Many downtown business area streets are swept daily, whereas residential areas receive cleaning on a biweekly or monthly schedule. A survey was conducted as a part of this study to determine current street cleaning practices by sending a questionnaire to some 500 cities. Replies were received from 149 cities.

Cities were asked to designate the frequency with which they flushed and/or swept various categories of streets: residential, commercial, downtown business, arterial, industrial, park, private, and other. Under both the flushing and sweeping categories the choices given as to frequency of cleaning were daily, biweekly, weekly, bimonthly, monthly, and other. Analysis of the survey data was difficult because of the large number of responses in the "other" category.

A summary of the results of this survey will be found in Table 11, Analysis of Frequency of Street-Cleaning Activities by City Size and Geographical Location. Some practices tend to be the same throughout the country for each category of street.

Approximately 25 percent of the cities that responded flush some of their residential streets; the majority do so on either a weekly or monthly schedule. Of the nearly 80 percent of the responding cities which regularly sweep their residential streets, over half do so either weekly or monthly.

While the amount of survey data relating to the cleaning of commercial streets were not as numerous as for residential areas, it appears that most cities flush some of their commercial streets weekly while sweeping them either daily or weekly.

Twenty-five percent of the cities flush their arterial streets, primarily on a weekly basis. Nearly half of the responding cities report sweeping of arterial streets on a weekly basis.

Some streets in downtown business areas are flushed in approximately 40 percent of the responding cities, while nearly 70 percent sweep them daily.

Few cities had the classification "industrial street" and those that did indicated little uniformity in cleaning schedule. Only 15 percent of the responding cities flushed some industrial streets; 30 percent regularly swept them. Of those reporting, most cleaned these streets weekly.

On the remaining streets listed—park, private, and "other," which were quite often state highways—only about 20 percent of the responding cities carried out any routine cleaning program. Where sweeping was scheduled, it generally varied between weekly and monthly.

A possible explanation as to why residential streets seem to have a more frequent cleaning schedule than the other classifications of streets is that many cities do not have their streets separated into the categories listed in the survey questionnaire. While most cities have residential or local

TABLE 11. Analysis of Frequency of Street Cleaning Activities
(By City Size and Geographical Location)

Commercial Streets

Flushing Frequency

City Size	Daily	Biweekly	Weekly	Bimonthly	Monthly	Other	Total
0-10,000			2				2
10,001-25,000	2	1	5				8
25,001-100,000	4	1	5	1	1	2	14
100,000-1,000,000	2	2	10		1	7	22
over 1,000,000	1		1				2
Geographic Location							
East	2		10	1		2	15
South	3	4					7
Midwest	2	2	6		2	2	14
Southwest						1	1
West	2	2	4			4	12
Total	9	8	20	1	2	9	49

Sweeping Frequency

City Size	Daily	Biweekly	Weekly	Bimonthly	Monthly	Other	Total
0-10,000			2			2	4
10,001-25,000	5	1	7	1	1	2	17
25,001-100,000	9	4	11	2	2	5	33
100,001-1,000,000	10	2	12	1	2	1	28
over 1,000,000	1		1				2
Geographic Location							
East	8	2	11	1	2	4	28
South	4		4			2	10
Midwest	5	1	11	2	1	1	21
Southwest	1	2				1	4
West	7	2	7	1	2	2	21
Total	25	7	33	4	5	10	84

Residential Streets

Flushing Frequency

City Size	Daily	Biweekly	Weekly	Bimonthly	Monthly	Other	Total
0-10,000		1	1				2
10,001-25,000		1	3		2		6
25,001-100,000		2	5		3	4	14
100,001-1,000,000			3		3	7	13
over 1,000,000				1		1	2
Geographic Location							
East		3	3		3	3	12
South		1	3			3	7
Midwest			3		4	4	11
Southwest						1	1
West			3	1	1	1	6
Total		4	12	1	8	12	37

Sweeping Frequency

City Size	Daily	Biweekly	Weekly	Bimonthly	Monthly	Other	Total
0-10,000			3		2	3	8
10,001-25,000	1	2	11	4	6	3	27
25,001-100,000	4	4	11	5	8	11	43
100,001-1,000,000	1	3	7	3	17	7	38
over 1,000,000					1	1	2
Geographic Location							
East	4	3	11	3	14	13	48
South	1	2	3	1	1	5	13
Midwest		1	7	5	11	3	27
Southwest		2			2	2	6
West	1	1	11	3	6	2	24
Total	6	9	32	12	34	25	118

Downtown Business Streets

Flushing Frequency

City Size	Daily	Biweekly	Weekly	Bimonthly	Monthly	Other	Total
0-10,000			2				2
10,001-25,000	5		3		2	1	11
25,001-100,000	9	1	4		1	3	18
100,001-1,000,000	14	2	4	1	1	3	25
over 1,000,000	1					1	2
Geographic Location							
East	8		8		1	4	21
South	6						6
Midwest	7	1	5		1	3	17
Southwest						1	1
West	8	2	1	2			13
Total	29	3	14	2	2	8	58

Sweeping Frequency

City Size	Daily	Biweekly	Weekly	Bimonthly	Monthly	Other	Total
0-10,000	2		2				4
10,001-25,000	11	2	3			5	21
25,001-100,000	25	1	5	1		4	36
100,001-1,000,000	30	1	2			1	34
over 1,000,000	1					1	2
Geographic Location							
East	24	1	5	1		7	38
South	8					2	10
Midwest	14	2	5			1	22
Southwest	5	1					6
West	18		3			1	22
Total	69	4	13	1		11	98

Arterial Streets

Flushing Frequency

City Size	Daily	Biweekly	Weekly	Bimonthly	Monthly	Other	Total
0-10,000							
10,001-25,000		1		1	3		5
25,001-100,000		3	7		3		13
100,001-1,000,000	1	2	7		1	5	16
over 1,000,000		1	1				2
Geographic Location							
East		3	4		2	1	10
South			2		1		3
Midwest	1	2	5		3	2	13
Southwest						1	1
West		2	4	1	1	1	9
Total	1	7	15	1	7	5	36

Sweeping Frequency

City Size	Daily	Biweekly	Weekly	Bimonthly	Monthly	Other	Total
0-10,000						2	2
10,001-25,000	1	1	2	1	3		8
25,001-100,000	1	6	14	4	2	4	31
100,001-1,000,000	5	1	19	1		3	29
over 1,000,000		1	1				2
Geographic Location							
East		3	11	2	3	3	22
South	1	2	5			1	9
Midwest	1	2	9	1	2	2	17
Southwest	2		3	1			6
West	3	2	8	2		3	18
Total	7	9	36	6	5	9	72

Industrial Streets

Flushing Frequency

City Size	Daily	Biweekly	Weekly	Bimonthly	Monthly	Other	Total
0-10,000							
10,001-25,000			2		1	1	4
25,001-100,000		1	4	1	2		8
100,001-1,000,000		2	2		2	4	10
over 1,000,000		1					1
Geographic Location							
East		1	2	1	2	2	8
South			2				2
Midwest		2	1		2	2	7
Southwest							
West		1	3		1	1	6
Total		4	8	1	5	5	23

Sweeping Frequency

City Size	Daily	Biweekly	Weekly	Bimonthly	Monthly	Other	Total
0-10,000						1	1
10,001-25,000			3		1	1	5
25,001-100,000	1	1	9	2	1	3	17
100,001-1,000,000	1		13	2	4	2	22
over 1,000,000		1					1
Geographic Location							
East	1	1	6	1	3	2	14
South	1		5			1	7
Midwest		1	4	2		1	8
Southwest					3	1	4
West			10	1		2	13
Total	2	2	25	4	6	7	46

Park, Private, and Other Streets

Flushing Frequency

City Size	Daily	Biweekly	Weekly	Bimonthly	Monthly	Other	Total
0-10,000							
10,001-25,000			1				1
25,001-100,000		1	2			1	4
100,001-1,000,000				1	1	1	3
over 1,000,000				1			1
Geographic Location							
East			1		1	1	3
South							
Midwest		1				1	2
Southwest							
West			2	2			4
Total		1	3	2	1	2	9

Sweeping Frequency

City Size	Daily	Biweekly	Weekly	Bimonthly	Monthly	Other	Total
0-10,000			1			2	3
10,001-25,000			3		2		5
25,001-100,000	2	1	3		2	5	13
100,001-1,000,000			4		6	2	12
over 1,000,000			1				1
Geographic Location							
East	1		3		3	6	13
South			1		1		2
Midwest		1	2		4	3	10
Southwest					2		2
West	1		6				7
Total	2	1	12		10	9	34

streets, the classes of commercial, downtown business, arterial, and industrial may be divided as such or be separated into the more functional classification of "collector," "arterial," and "freeway." Some cities did not even report this type of breakdown and listed all their streets under only one or two categories. The questionnaire form is included in the appendix to this report to indicate the scope of the inquiry.

The frequency of street cleaning, if pollution control is regarded as a major consideration, should be based on neighborhood characteristics, notably the tendency to create street litter, and the frequency of precipitation. In an effort to determine the frequency of precipitation, a computer program was developed by Consoer, Townsend, and Associates, Consulting Engineers, to analyze the hourly precipitation-event records maintained by the National Weather Bureau Center. Precipitation events for Midway Station, Chicago, were analyzed. The maximum, minimum, and average intervals between events with 0.04, 0.5, 1.0, and 2.0 inches of rainfall were analyzed for a 20-year period of record by one-half month periods. In the hope of consolidating small, semi-continuous events, the precipitation was considered to represent only one event if not more than two hours without precipitation elapsed between individual hourly events. The results of this analysis are summarized in Table 12, Twenty-Year Hourly Frequency of Rainfall Events, Chicago, Illinois.

If this type of information were used as a guide and it were desired to minimize the amount of litter on a street prior to precipitation events, street cleaning would be required, for example, from every three days in April to every seven days in August.

During the study, several tests were made to determine the amount of material that remained after regular street cleaning. Sections tested were taken at random. It was observed that the material not picked up by the sweeper represented a uniform layer of dust and dirt. A sidewalk type sweeper was used to cover a 24-inch swath of pavement previously swept and the amount collected was converted to lb/100 ft of curb. The results are summarized in Table 13, Material Remaining After Street Cleaning. In all cases, the test street was cleaned twice and the sample obtained immediately following the second cleaning.

Two additional tests were made to determine the efficiency of pickup by weighing the street sweepings collected as opposed to the material left behind. A distance of one mile was cleaned by one pass of a regular mechanical sweeper and a representative sample taken to determine the composition of the material. The sidewalk type sweeper was then used to clean a 283-foot long swath that appeared to be representative of the total length swept. Following this, a small shop-type vacuum was used to determine if there was additional material left on the surface that the larger vacuum device had not removed. Five 4x10 foot squares were vacuumed. Test results verified that the vacuum sidewalk sweeper had removed almost all of the material. A section of the vacuumed area was then tested to determine the amount of dust and dirt left in the interstices of the paved surface material. The entire test was repeated the next day on the opposite side of the one-way street.

TABLE 12. Twenty-year Hourly Frequency of Rainfall Events, Chicago

Part 1 For Precipitation Equal/Greater than 0.04 Inches Per Event

Period		Max. Interval Between Events (Hrs.)	Min. Interval Between Events (Hrs.)	Average No. of Events Per Period	Average Interval Between Events (Hrs.)
From	Thru				
Jan. 1 -	Jan. 15	405	3	2.89	109.1
Jan. 16 -	Jan. 31	428	3	3.84	94.7
Feb. 1 -	Feb. 15	347	3	3.10	97.0
Feb. 16 -	Feb. 28	304	3	3.15	80.6
Mar. 1 -	Mar. 15	330	3	4.31	66.8
Mar. 16 -	Mar. 31	394	3	4.52	79.5
Apr. 1 -	Apr. 15	306	3	4.36	69.0
Apr. 16 -	Apr. 30	343	3	5.94	56.1
May 1 -	May 15	425	3	3.21	95.9
May 16 -	May 31	352	3	4.63	76.1
Jun. 1 -	Jun. 15	442	3	4.15	84.2
Jun. 16 -	Jun. 30	560	3	3.52	87.8
Jul. 1 -	Jul. 15	321	3	3.35	85.7
Jul. 16 -	Jul. 31	302	3	4.80	74.7
Aug. 1 -	Aug. 15	547	3	3.35	108.7
Aug. 16 -	Aug. 31	623	3	3.25	125.2
Sep. 1 -	Sep. 15	394	4	2.30	113.5
Sep. 16 -	Sep. 30	580	3	3.25	124.7
Oct. 1 -	Oct. 15	596	3	2.65	104.7
Oct. 16 -	Oct. 31	658	3	2.60	128.0
Nov. 1 -	Nov. 15	639	3	3.05	100.3
Nov. 16 -	Nov. 30	707	4	3.15	101.9
Dec. 1 -	Dec. 15	526	3	3.35	102.9
Dec. 16 -	Dec. 31	480	3	2.60	117.1

Part 2 For Precipitation Equal/Greater than 0.50 inches Per Event

Period		Max. Interval Between Events (Hrs.)	Min. Interval Between Events (Hrs.)	Average No. of Events Per Period	Average Interval Between Events (Hrs.)
From	Thru				
Jan. 1 -	Jan. 15	1,787	171	0.42	829.7
Jan. 16 -	Jan. 31	3,092	3	0.63	683.5
Feb. 1 -	Feb. 15	1,141	3	0.42	530.6
Feb. 16 -	Feb. 28	1,619	72	0.36	707.0
Mar. 1 -	Mar. 15	1,091	41	0.63	382.5
Mar. 16 -	Mar. 31	763	93	0.68	380.5
Apr. 1 -	Apr. 15	919	48	0.73	382.0
Apr. 16 -	Apr. 30	1,422	9	1.47	299.2
May. 1 -	May 15	1,397	104	0.42	534.2
May. 16 -	May 31	807	25	0.89	350.0
Jun. 1 -	Jun. 15	1,042	6	1.36	304.4
Jun. 16 -	Jun. 30	669	48	0.63	329.0
Jul. 1 -	Jul. 15	734	8	0.95	299.1
Jul. 16 -	Jul. 31	1,391	10	1.65	297.6
Aug. 1 -	Aug. 15	2,423	5	0.95	433.8
Aug. 16 -	Aug. 31	2,399	20	0.95	576.8
Sep. 1 -	Sep. 15	1,709	18	0.65	424.1
Sep. 16 -	Sep. 30	1,482	7	1.05	337.0
Oct. 1 -	Oct. 15	3,039	5	0.80	616.6
Oct. 16 -	Oct. 31	1,207	3	0.40	541.6
Nov. 1 -	Nov. 15	3,633	6	0.50	1,060.3
Nov. 16 -	Nov. 30	1,497	33	0.45	594.1
Dec. 1 -	Dec. 15	1,138	4	0.50	395.3
Dec. 16 -	Dec. 31	1,965	7	0.70	519.4

Part 3 For Precipitation Equal/Greater than 1.00 inches Per Event

Period From		Thru	Max. Interval Between Events (Hrs.)	Min. Interval Between Events (Hrs.)	Average No. of Events Per Period	Average Interval Between Events (Hrs.)
Jan.	1 - Jan.	15	4,205	1,623	0.15	3,735.3
Jan.	16 - Jan.	31	1,254	587	0.10	920.5
Feb.	1 - Feb.	15	1,085	1,085	0.00	0.0
Feb.	16 - Feb.	28	0	0	0.00	0.0
Mar.	1 - Mar.	15	2,130	665	0.05	2,795.0
Mar.	16 - Mar.	31	2,658	343	0.21	1,236.2
Apr.	1 - Apr.	15	2,459	393	0.15	1,700.3
Apr.	16 - Apr.	30	2,526	18	0.47	842.2
May	1 - May	15	1,384	275	0.05	1,659.0
May	16 - May	31	1,744	178	0.36	982.8
Jun.	1 - Jun.	15	2,287	7	0.47	782.3
Jun.	16 - Jun.	30	1,010	118	0.15	598.3
Jul.	1 - Jul.	15	1,866	54	0.50	684.7
Jul.	16 - Jul.	31	6,715	43	0.80	1,352.8
Aug.	1 - Aug.	15	2,409	5	0.40	1,079.0
Aug.	16 - Aug.	31	5,616	41	0.40	1,107.1
Sep.	1 - Sep.	15	5,149	18	0.25	1,654.2
Sep.	16 - Sep.	30	4,524	17	0.40	1,629.6
Oct.	1 - Oct.	15	5,373	26	0.25	2,347.8
Oct.	16 - Oct.	31	5,489	503	0.10	3,924.5
Nov.	1 - Nov.	15	4,730	6	0.20	2,476.2
Nov.	16 - Nov.	30	2,716	1,426	0.05	4,142.0
Dec.	1 - Dec.	15	2,500	230	0.10	1,522.5
Dec.	16 - Dec.	31	3,259	468	0.10	2,124.0

Part 4 For Precipitation Equal/Greater than 2.00 inches Per Event

Period From		Thru	Max. Interval Between Events (Hrs.)	Min. Interval Between Events (Hrs.)	Average No. of Events Per Period	Average Interval Between Events (Hrs.)
Jan.	1 - Jan.	15	4,097	4,097	0.00	0.0
Jan.	16 - Jan.	31	0	0	0.00	0.0
Feb.	1 - Feb.	15	0	0	0.00	0.0
Feb.	16 - Feb.	28	0	0	0.00	0.0
Mar.	1 - Mar.	15	0	0	0.00	0.0
Mar.	16 - Mar.	31	4,576	4,576	0.00	0.0
Apr.	1 - Apr.	15	0	0	0.00	0.0
Apr.	16 - Apr.	30	1,835	1,404	0.05	3,239.0
May	1 - May	15	1,804	1,384	0.05	3,188.0
May	16 - May	31	0	0	0.00	0.0
Jun.	1 - Jun.	15	7,593	6,861	0.05	14,454.0
Jun.	16 - Jun.	30	4,769	535	0.05	5,304.0
Jul.	1 - Jul.	15	9,401	661	0.10	9,030.5
Jul.	16 - Jul.	31	12,503	4,377	0.15	10,910.6
Aug.	1 - Aug.	15	16,082	791	0.05	16,873.0
Aug.	16 - Aug.	31	16,290	0	0.00	0.0
Sep.	1 - Sep.	15	14,154	233	0.05	14,387.0
Sep.	16 - Sep.	30	0	0	0.00	0.0
Oct.	1 - Oct.	15	7,697	147	0.05	7,844.0
Oct.	16 - Oct.	31	0	0	0.00	0.0
Nov.	1 - Nov.	15	0	0	0.00	0.0
Nov.	16 - Nov.	30	0	0	0.00	0.0
Dec.	1 - Dec.	15	0	0	0.00	0.0
Dec.	16 - Dec.	31	3,259	3,259	0.00	0.0

Study period from July 1, 1948 to December 31, 1967.

Data obtained thru U.S. Weather Bureau at Midway Airport, Chicago.

The results of these two tests are summarized in Table 14, Analysis of Special Sweeping Tests on Michigan Avenue. Although conditions on both sides of the street appeared identical, there was a large difference in the amount of street litter and the efficiency of the sweeper. In this test, only one sweeping was performed, not two, as is the usual practice in Chicago.

In an effort to define the pollutional characteristics of in-place dust and dirt, swept dust and dirt, and dust and dirt left after street cleaning, samples of each type were obtained from a single location. The laboratory analysis of the samples showed no significant difference in the amount of pollutants present.

Findings from these sweeping studies made it apparent that a controlled test should be made to determine the actual capability of mechanical-type pickup sweepers. Inasmuch as any such comprehensive testing program —involving variations in machine design, broom construction and material, and operating conditions—would be time consuming and costly, it was concluded that a pilot test, using sweeping machines and brooms identical to that used by the City of Chicago should be undertaken. The Wayne Manufacturing Company of Pomona, California, under a contract with the APWA, conducted tests to determine the maximum performance of their sweeper and Mark I Milemaster Broom to pick up the dirt and dust fraction of street litter. The tests were conducted in Pomona on new, level, open-graded and well-rolled, asphaltic concrete pavement, under the observation of a representative of the study. Procedure and results are contained in Appendix E.

For comparison purposes, both a three-wheel Model 984 and a four-wheel Model 945 were used. Different broom speeds and amounts of simulated litter (dust and dirt) were used and broom patterns of five, seven, and nine inches utilized. In addition, two vacuum sweepers were evaluated, an Airjet Model 770, used for airport runway cleaning, and a Starsweep Model 554, used for factory floor and sidewalk cleaning. The test parameters represented reasonable ranges for the sweeping machines, as recommended by their manufacturer.

Efficiency of cleaning was measured as the ratio of material swept up to the original amount of material. The material chosen was Number 16 sand; the screen size and distribution of sizes approximately the dust and dirt fractions of Chicago street litter.

The amount of dust and dirt used in the tests was 0.05 and 0.1 lb/sq ft. This represented a range of 1.07 to 2.14 lb/day/100 ft assuming sweeping every 14 days. These amounts fall within the usual ranges of accumulation in Chicago. The broom pattern widths of nine and seven inches are in excess of that normally used and would result in greatly increased broom wear, with a resulting increase in cost.

Test results are summarized in Figure 6, Efficiency of Sweeping Dust and Dirt. The performance was high for all combinations tested. Best results were obtained with the vacuum units where an efficiency in excess of 95 percent was obtained.

TABLE 13. Material Remaining After Street Cleaning

Col. No.	1	2	3	4	5
Date	Zone	Length	Material Picked up by Vacuum in 2' Width*	Dust - Dirt Picked up Adjacent to Curb	Estimated Remaining Total lb. of Dust - Dirt per 100 Ft. Curb**
July 26	R-1	246'	54 oz.	38 oz.	8.25 lbs.
July 26	R-1	250'	115.5 oz.	35.5 oz.	12.44 lbs.
Aug. 8	R-5	200'	31 oz.	5.5 oz.	4.06 lbs.
Aug. 9	R-4	198.75'	124.5 oz.	1.5 oz.	15.62 lbs.
Aug. 9	R-4	192'	22 oz.	12 oz.	3.12 lbs.
Aug. 9	R-4	200'	10 oz.	24 oz.	2.0 lbs.
Aug. 23	C-1	200'	13.5 oz.	56.5 oz.	3.44 lbs.
Aug. 23	R-3	200'	8.5 oz.	49.5 oz.	2.61 lbs.
Aug. 23	R-3	200'	28 oz.	66 oz.	5.56 lbs.
Aug. 23	R-3	200'	4.5 oz.	17.5 oz.	1.12 lbs.

*Multiply by 4 for total

**(((Col. 3 x 4) + Col. 4) ÷ Col. 2)

TABLE 14. Analysis of Special Sweeping Tests on Michigan Avenue

Item	Sept. 5 East Side	Sept. 6 West Side
A. Machine Sweeping		
Length, (ft.)	5,102	4,803
Lb. Swept	220	260
Lb./100 ft.)	4.31	5.44
Dust & Dirt (by weight)	65.2%	51.2%
Dust & Dirt (lb./100 ft.)	2.81	2.79
B. Vacuum Sweeping		
Length, (ft.)	283.5	250
Lb. Swept	11.5	1.4
Lb./100 ft.)	4.07	.56
Dust & Dirt (by weight)	92.8%	57.7%
Dust & Dirt (lb./100 ft.)	3.76	0.32
C. Shop Vacuum		
Area Swept (sq. ft.)	150.2	150.2
Total Wt. Swept	6 oz. or 1 lb./100 ft. of curb	
D. Washing Test		
Area Washed (sq. ft.)	28.41	28.41
Water Used (1)	15.56	15.56
Water Used to wet surface (1)	3.96	1.74
Length/sq. ft.)	0.14	0.06
Vol. Dust & Dirt Collected	24.4 or 56 g	12.4 or 28.5g
Dust & Dirt (lb./100 ft.)	4.1	2.17
Total Dust & Dirt (lb./100 ft.)	11.7	6.28

	Sample From				
	Shop Type Vacuum	Sidewalk Type Vacuum		Machine Sweeper	
	Composite	East Side	West Side	East Side	West Side
E. Laboratory Findings					
5-day BOD (mg/g)	4.32	7.52	5.76	7.36	2.26
COD (mg/g)	62.5	147.3	62.3	66.9	32.2
Nitrogen N (mg/g)	.794	.686	.794	1.028	.720
Water Soluble (mg/g)	10.08	13.00	13.66	11.76	5.52
Volatile Water Soluble (mg/g)	6.24	7.30	7.74	7.30	2.42
Phosphate as PO_4 (mg/g)	.04	0.04	.06	0.04	0.02
Plate Count (no.) (x1000)	4,420	2,740	3,960	2.700	3,540
Confirmed Coliform (MPN/g) (x1000)	2,900	1,900	1,300	1,200	1,200
Fecal Enterococci (MPN/g)	420	0	240	46	240

Sweeping efficiency of conventional sweepers generally varied with the broom pattern, being highest for the nine inch and lowest for the five inch. Despite great care, the results of runs were not closely reproducable, as indicated by the scattering of data points in Figure 6. The total efficiency of a mechanical sweeper is the combination of the efficiencies of both the gutter and pick up broom. Thus if both brooms had an efficiency of 90 percent, the resulting total efficiency would be 81 percent. As mentioned, the gutter brooms were not used in the tests in order to eliminate one variable and because of visually determined apparent high efficiency of gutter brooms in Chicago.

The efficiencies determined must be considered as optimal. It should be noted that the material was collected dry—no water spray was used. In addition, the gutter broom was not used, as the material was spread uniformly along the test patch. Excessive dust conditions were not encountered, due perhaps to the particle sizes involved and perhaps because a gutter broom was not used to dislodge the material.

The efficiencies of the pickup broom of the sweepers tests, at a broom pattern of five inches, is indicated in the following tabulation.

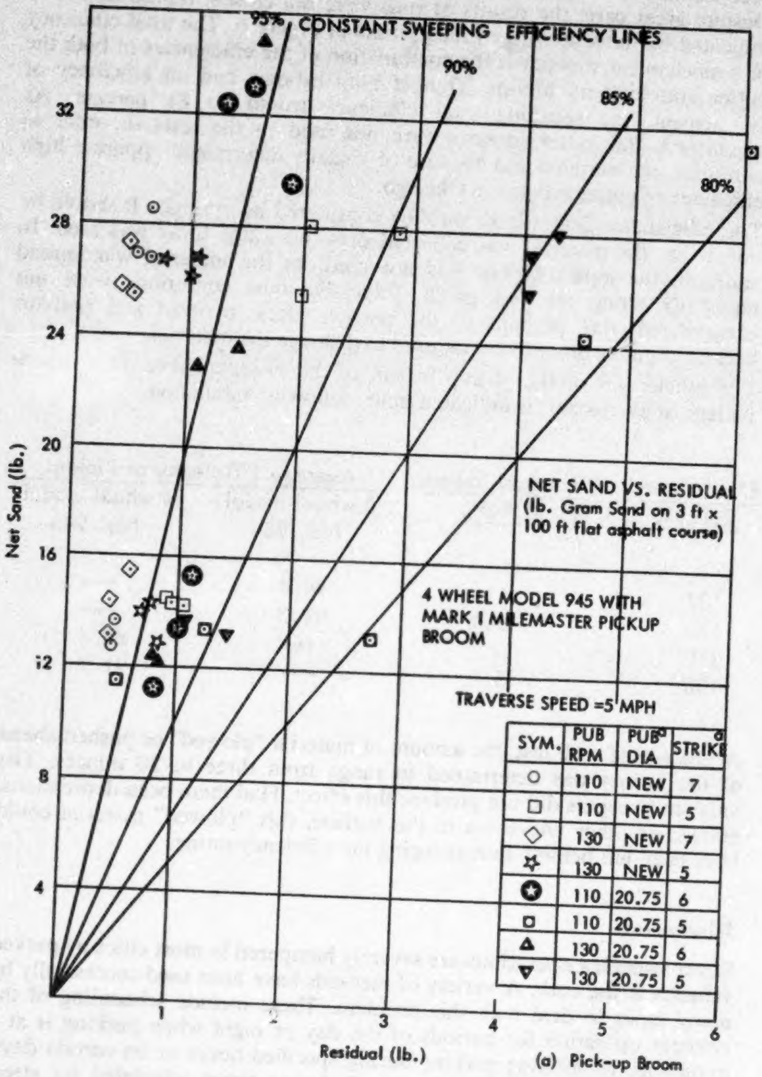
Broom Speed R.P.M.	Forward Speed M.P.H.	Average Efficiency of Pickup 3 wheel model No. 984	4 wheel model No. 945
137	5	94.4	---
175	6.4	91.3	---
110	5	---	88.4
130	5	---	91.9

At the end of each test, the amount of material "plowed" or pushed ahead of the broom was determined to range from three to 30 ounces. The vacuum sweepers did not produce this effect. Had there been depressions, cracks, or other uneveness in the surface, this "plowed" material could have been left behind, thus reducing the efficiency rating.

Discussion

Street sweeping operations are severely hampered in most cities by parked vehicles at the curb. A variety of methods have been used successfully by many cities to deal with this problem. These include scheduling of the sweeper operation for periods of the day or night when parking is at a minimum, prohibiting parking during specified hours or on certain days, and posting notices of "no parking" during times scheduled for street cleaning. The latter method is widely used in Chicago where population density and lack of off-street parking space has resulted in almost constant use of the streets for parking.

FIGURE 6-a. Efficiency of Sweeping Dust and Dirt



SYM.	PUB RPM	PUB DIA[a]	STRIKE[a]
○	110	NEW	7
□	110	NEW	5
◇	130	NEW	7
☆	130	NEW	5
✪	110	20.75	6
▣	110	20.75	5
▲	130	20.75	6
▼	130	20.75	5

(a) Pick-up Broom

FIGURE 6-b. Efficiency of Sweeping Dust and Dirt

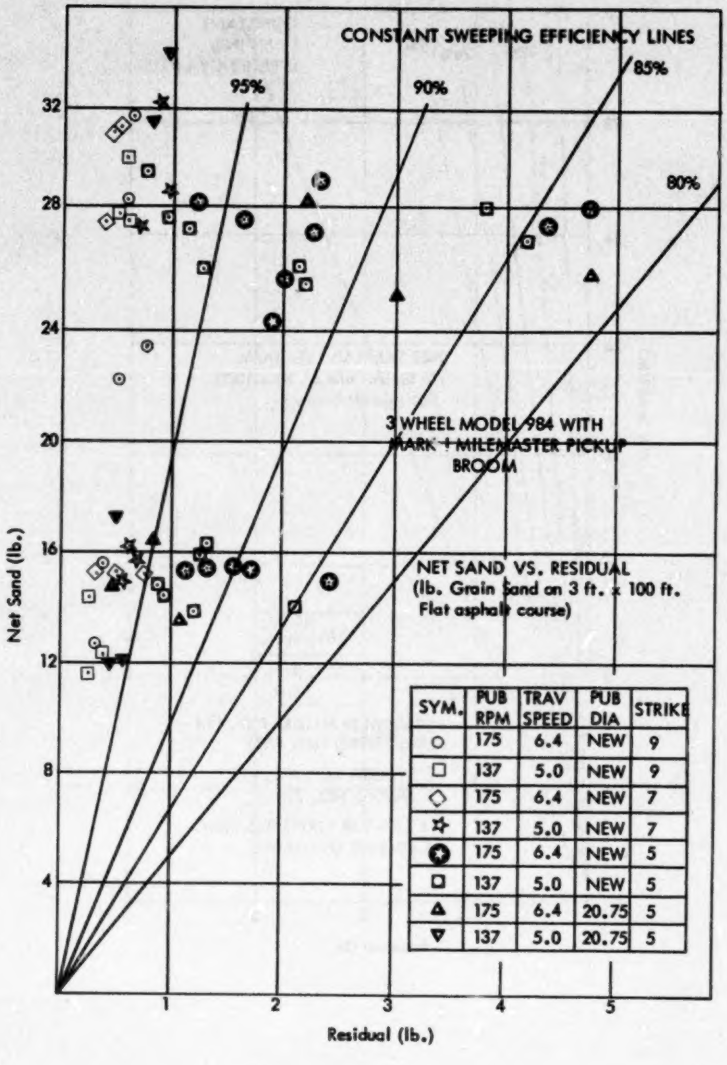
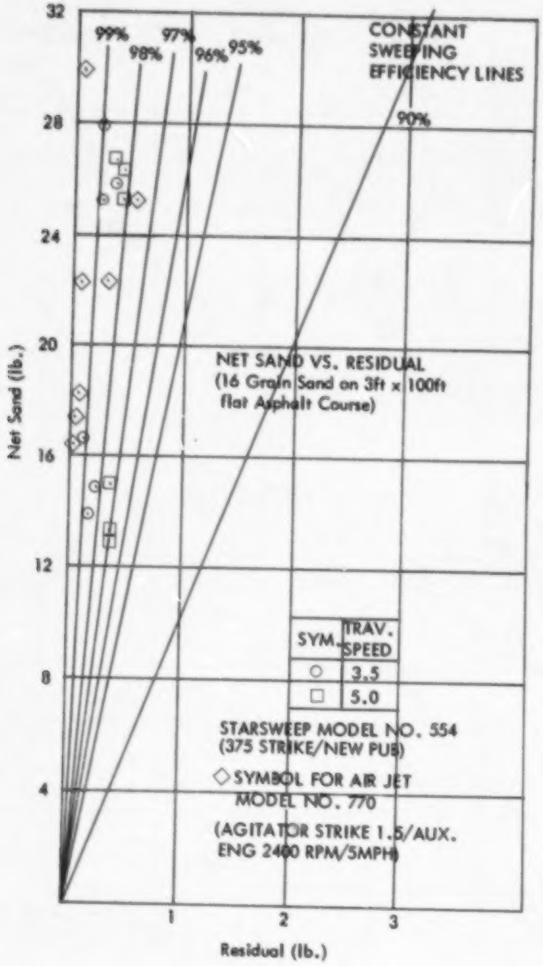


FIGURE 6-c. Efficiency of Sweeping Dust and Dirt



The operation in Chicago involves the placement of cardboard signs on trees or posts, or setting out wooden signs the day before sweeping and removing the signs after sweeping, except on arterial streets where parking is prohibited during rush hours in the direction of the heaviest traffic.

The hours of the parking restrictions are limited to the period when residents normally may be away working, namely 9 A.M. - 4 P.M. The street cleaning operation is costly and the system does not allow flexibility in meeting changes in weather conditions, equipment breakdown, and changing field conditions encountered.

Parking needs are so great in some areas that even temporary restrictions are not acceptable to motorists. New York City recently attempted a program of having vehicles park 18 inches from the curb in order that hand sweeping could be used to clean the area of greatest litter accumulation next to the curb. Motorists could not be educated to park that far from the curb during the limited trial and in most states parking laws require parked vehicles to be within 12 to 18 inches of the curb.

It would appear that to achieve high efficiency in removing dust and dirt from streets that vacuum removal could be used. However, a re-evaluation of the design of the sweeper would also be appropriate. For instance, existing equipment removes most of the litter from the gutter and spreads it out across the street surface. A second broom, which cannot be adjusted to changing street conditions, then attempts to flick the material on a conveyor. Efficiency might be improved if the material could be picked up directly from the gutter area where it has been deposited. An additional factor in the pickup of dust and dirt is electrical attraction between dust and dirt particles and the broom fiber. Perhaps this force of electrostatic attraction should be explored as a method to remove fine material.

The significance of street sweeping practices to the pollution potential of litter is obvious. The better and more frequent the cleansing operations, the less the pollution effect.

Regulations of many jurisdictions require that off-street parking spaces be provided for businesses and residential structures. Such regulations are constantly being reviewed because of resistance from property owners to the high cost of providing such parking facilities. The problem is particularly acute where structures are remodeled to provide for additional and multiple-dwelling units and in situations where there may be more than one automobile per family. Development of off-street parking areas is needed in many areas before regulations can be enforced that would facilitate frequent street sweeping.

Street Flushing

Street flushing by means of mechanical flushers or the use of fire hydrants and long hoses appears to play only a small role in the cleaning of streets. A 1955 survey by the American Public Works Association revealed that of the 493 flushing units in use by 64 of the 96 cities reporting, 231 were owned by one municipality. Ninety-one cities in the same survey reported the use of 811 machine sweepers, 259 of which were owned by one municipality.

At one time the general practice was to "flood" the street, that is, use enough water to wash all material to the gutter and to flush lighter materials to the sewer inlet. Other jurisdictions have used flushers in conjunction with street sweepers, either before or after sweeping.

The use of flushers to "flood" a street is time-consuming and requires liberal quantities of water. The capacity of the machines used varies from 1,000 to 5,000 gallons, necessitating frequent refilling.

Several jurisdictions have installed high-pressure nozzles on their flushers in an attempt to move material from the travel lanes over to the parking lane. The flusher can thus clean a portion of the street while moving at near normal street traffic speeds.

Street flushing prior to motor sweeping is also practiced in many locations where the center divider is defined by street markings on grade—not by raised traffic islands—in order to force the material to the roadside where it is then picked up by the sweeper.

Streets are also flushed following mechanical sweeping to remove fine dust and dirt. Flushing is also used to washaway "sweeper trails" in localities where there is considerable dry weather water flow in the gutters from excessive lawn sprinkling. Such conditions create a smearing pattern in the curb lanes behind sweepers which can best be removed by flushing.

Inasmuch as street flushing is not used to any great extent by municipalities, and where used, only small amounts of water reach the street inlets, field tests of flushers were not conducted. As mentioned in the report of the special tests made on Michigan Avenue, (Table 14), a pilot test of the effects of flushing was carried out to ascertain the pollutional potential of dust and dirt material remaining on the street surface after complete sweeping. The dust and dirt found in the wash water from this test were an indication of the pollution that could be added to sewer inlets by effective flushing, over and above the pollution potential of litter collected by the routine street-sweeping operations evaluated in the project studies.

References

1. HORTON, JOHN P. "The Street Cleaning Revolution." *The American City. LXXVIII, 4. pp 104-106. April, 1963.*

Catch Basins

Storm-water runoff in urban areas normally flows for a short period of time in the gutter and is diverted by an inlet structure leading to an underground conduit or open channel for transport to a receiving body of water. The underground conduit, either storm sewers or combined sewers, may be protected by catch basins built in conjunction with the inlet structures. In Chicago, storm-water inlets with catch basins are installed at both ends of the curb return at an intersection (to prevent the ponding of drainage where pedestrians cross a street) and at very regular intervals along the curb.

A sketch of the catch basin design used by the City of Chicago is shown in Figure 7. The practice of trapping the catch basin as indicated in the sketch was discontinued for several years but is now required.[b)]

Historically, the purpose of catch basins was to prevent sewer clogging and to prevent odor emanations from the sewers by providing a water seal. The first function served by catch basins was especially important prior to the existence of good quality street pavements. In areas where streets were partially or wholly unpaved, significant quantities of stone, sand, and other materials were washed into the sewer system during periods of rainfall. Also, during the earlier years of sewer construction, little attempt was made to maintain self-cleaning velocities in sewers of at least two feet per second.

Catch basins are normally built under the inlet gratings or openings in the street. The typical catch basin is made of concrete, brick, or precast concrete with a total depth of about eight feet and with a holding capacity below the outlet sewer invert of about one cubic yard.(1)

The range in sump capacity of catch basins is from one cubic foot to 81 cubic feet (3 cubic yards). A water seal is commonly included in a catch basin to prevent the escape of sewer odors.

A review of the literature indicates that the usefulness of catch basins was considered marginal even as early as the turn of the century. Folwell(2) presented the following discussion of catch basins in a textbook published in 1900.

> "Objection to catch basins is that several days must elapse, and several weeks usually do, between the beginning of a storm and cleaning of catch basins; and during this time the organic matter has been washed or thrown into inlets including horsedroppings, fruit and vegetable refuse, et cetera is putrefying and frequently emitting foul odors. . . .A small catch basin is worse than useless. A catch basin is desirable where sewers grades are flat and velocity is less than three feet/second; also on combined sewers where streets are unpaved. . . . To be at all efficient, catch basins should extend more than 18 inches below connection pipe, since a heavy rain will keep the water in it so stirred up as to wash out any deposits above that point. . . . Instead of placing a catch basin at each inlet it is sometimes preferable to place silt-basins along line of sewers at intervals of 1,000 feet or more with a manhole above for ventilation and cleaning."

Subsequent texts generally concurred with Folwell's analysis of catch basins, e.g., reference(3) and current texts generally provide only a short disclaimer regarding the value of catch basins. For example, the recent text by Fair et al. states:(4)

> "Catch basins need much maintenance; they should be cleaned after every storm and may have to be oiled to prevent production of large

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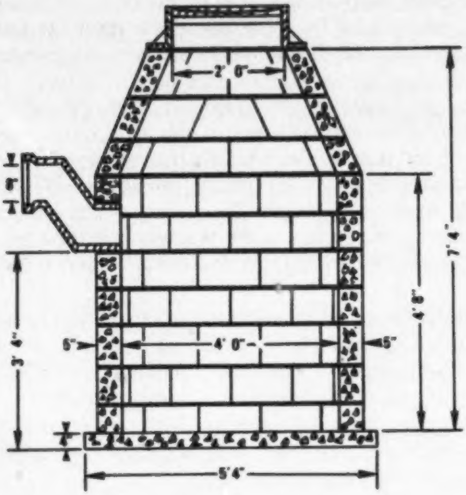
b)Historically, sewer gas was felt to be a health hazard and the traps were included for that purpose.(5)

FIGURE 7. Catch Basin Design, Chicago



Scale 1/2" = 1 ft.

> crops of mosquitoes. On the whole there is little reason for continuing their use in modern sewer systems."

Despite the purported reduced need for catch basins, they are still widely used in many jurisdictions in all parts of the country as shown by the 1956 survey of the American Public Works Association.(1) In answer to a questionnaire sent out in conjunction with this study, all (23) jurisdictions with combined sewers reported the continued use of catch basins.

To evaluate the role of catch basins in the pollution of storm-water runoff, the hydrology of a typical area and the hydraulic characteristics of catch basins for a 10-acre (4 ha) residential area typical of the Chicago area was studied.

A recent report analyzed the precipitation-runoff relationship that exists in the Chicago Metropolitan area, using the characteristics of the unit area described earlier as a basis for estimates.(6) The results of this report provide an excellent source of information for this study.

The unit area is 36 percent impervious. Approximately 54 percent of the impervious area is composed of streets and alleys and 46 percent is roof area. Thus, there are three area components of storm-water runoff: (1) runoff from streets and alleys, (2) runoff from rooftops connected directly to the sewer, and (3) runoff from pervious areas.

Figure 8, Rainfall-Runoff Relationships for Unit Area, Chicago, shows the rainfall-runoff relationship for the unit area, partitioned into these three components. It may be seen that for rainfalls of less than 2.2 inches, the runoff from pervious areas is negligible.

Table 15, Types of Storms Contributing to Storm-Water Overflows, shows the rainfall-runoff relationship and the quantity of overflow attributable to individual categories of rainfall. Analysis of this data reveals the important fact that the lighter rainfalls, due to their greater frequencies, are a prime cause of storm-water overflows. Also, only about one or two percent of the annual overflow is from pervious areas. Consequently, investigation of significant sources of pollution can generally be restricted to the impervious portion of the drainage area.

The estimated sanitary-sewage flow is about 100 gallons per capita per day. Since there are 281 persons in the area, the equivalent hourly sewage flow is equivalent to 0.0043 inches of runoff per hour from the 10-acre area, a small portion of the runoff shown in Table 15.

A recent study by Harza Engineers and by Bauer Engineers presents the estimated BOD and suspended solids in storm-water overflows from the unit area. These results are summarized in Table 16, Estimated Quality of Storm-Water Overflows. From 10-acre (4 ha) Unit Area, Chicago. They indicate that approximately 87-percent of the overflow, 74-percent of the BOD, and 71-percent of the suspended solids are caused by rainfalls of one inch or less. Consequently, these lighter, more frequent rains are a significant source of pollution from combined sewer overflows.

Role of Catch Basins in Storm Water Pollution

Although research has been conducted on the hydraulic characteristics of flow at the storm-water inlet, little investigation has been done regarding the hydraulic characteristics of flow within a catch basin. The only data disclosed by a bibliographical search were reports of investigations at the University of Illinois.(7 8) These reports concluded that catch basins are relatively inefficient as far as their hydraulic characteristics are concerned. For example, the sheet of water falling from the inlet to the ponded water in the basin creates currents that impede efficient discharge. Also, there is a tendency for air entrainment which causes a reduction in fluid density and subsequent increase in volume discharged. These tests were conducted in a basin with a sump of 20 inches depth, a commonly used size.

As a part of this study, a field test was made to determine whether full mixing of the incoming fluid (with the liquid already in the catch basin) occurred. A catch basin serving a street gutter drain had previously been substantially cleaned of solid sediments. This basin was filled with water, derived in part from the previous day's rain and in part from flow from a nearby hydrant.

The test procedure used was as follows: A hose and water meter were connected to a nearby hydrant, so that the volume (and approximate flow rate) of water could be measured. The hose outlet discharged to the surface of the street about six feet from the curb and about twenty feet

FIGURE 8. Rainfall Runoff Relationships for Unit Area, Chicago

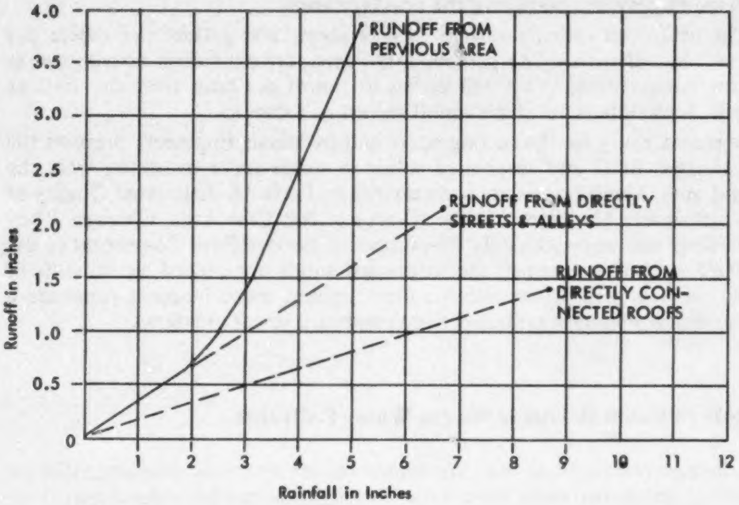


TABLE 15. Types of Storms Contributing to Storm-water Overflows

Rainfall Interval Inches	Average Rainfall Inches	Average Runoff Inches	No. of Events Per Year	Average Overflow Inches	Inches of Overflow Per Year	Cum. % of Annual Overflow
0 to .2	0.1	.03	78.0	.015	1.17	14.7
.2 to .4	0.3	.09	19.8	.07	1.39	32.1
.4 to .6	0.5	.15	9.6	.12	1.15	46.5
.6 to .8	0.7	.21	5.2	.17	.88	57.5
.8 to 1.0	0.9	.28	3.2	.23	.74	66.7
1.0 to 1.2	1.1	.35	2.4	.29	.70	75.5
1.2 to 1.4	1.3	.42	1.3	.34	.44	81.0
1.4 to 1.6	1.5	.49	.92	.41	.38	85.8
1.6 to 1.8	1.7	.56	.53	.47	.25	88.9
1.8 to 2.0	1.9	.63	.36	.53	.19	91.3
2.0 to 2.2	2.1	.70	.22	.58	.13	92.9
2.2 to 2.4	2.3	.76	.14	.64	.09	94.0
>2.4	3.0	1.26	.53	.91	.48	100.0

Total Overflows 7.99"

TABLE 16. Estimated Quality of Storm-water Overflows from 10-Acre (4 ha) Unit Area, Chicago

Rainfall Interval	Average 5-Day BOD mg/l	Average Suspended Solids mg/l	5-Day BOD per Year lbs.	Suspended Solids for Year lbs.	Cumulative % of Total		
					Overflow	BOD	S.S.
0 to .2	175	290	33.0	546	14.1	26.6	17.0
.2 to .4	125	270	28.0	610	32.1	49.1	37.5
.4 to .6	70	250	13.0	400	46.5	59.7	50.5
.6 to .8	70	230	10.0	337	57.5	67.7	61.4
.8 to 1.0	70	210	8.4	305	66.7	74.5	71.3
1.0 to 1.2	70	200	3.4	230	75.5	81.3	78.8
1.2 to 1.4	70	200	5.3	147	81.0	85.5	83.6
1.4 to 1.6	70	200	4.2	125	85.8	88.9	87.7
1.6 to 1.8	70	200	2.6	84	88.9	97.0	90.4
1.8 to 2.0	70	200	1.6	63	91.3	92.3	92.4
2.0 to 2.2	70	200	1.1	52	92.9	93.1	94.1
2.2 to 2.4	70	200	.8	32	94.0	93.7	95.1
>2.4	70	200	7.9	152	100.0	100.0	100.0
		Total	124.3	3086			

from the drain. All the metered water thus flowed down the gutter to the drain, in the same manner as rainwater would collect and flow during a rain storm. Tests were made at various flow rates and various periods of flow.

A stirring device was arranged so that the contents of the catch basin could be thoroughly mixed before each sample was taken for analysis. At the start of each test series, a quantity of salt (NaCl), between about 15 and 45 pounds was dissolved in water and then dumped into the catch basin and stirred for 15 minutes. The concentration of chloride was determined by the Bolhard method both at the beginning of the test and after each measured quantity of water had passed through the drain. (The volume of the catch basin was estimated at 353 gallons.)

Test Results:

The results of the tests are tabulated in Table 17, Test Results, Catch Basin Mixing by Incoming Flow.

The results of the tests are summarized in Figure 9, Relationship of Flow Into Catch Basin and Reduction of Concentration of NaCl. When compared to the ideal case of complete mixing, it was found that a consistent pattern of mixing with some minor displacement occurred. However, the results indicate that for all practical purposes complete mixing occurred.

Several samples of the liquid retained in catch basins were obtained in May, 1968 after several days without rainfall. Temperatures averaged in the sixties during this period. The 5-day BOD of the samples was as follows. The location refers to the previously described street refuse test areas.

Number	Location	Zoning	BOD mg/1 (ppm)
1	1	Commercial	225
2	1	Commercial	150
3	1	Commercial	35
4	2	Commercial	160
5	2	Commercial	60
6	16-17	Residential	50
7	16-17	Residential	85

If the previously described 10-acre (4ha) unit area of Chicago is used as a basis, the following magnitude of the pollution potential of the liquid retained in catch basins is obtained.

The 10-acre (4 ha) area contains 20 catch basins and has 72 dwelling units at an estimated occupancy of 3.9 persons per unit. The volume of liquid in a catch basin is approximately 350 gallons and the BOD of the liquid is assumed to be 60 mg/l. Therefore:

TABLE 17. Test Results, Catch Basin Mixing by Incoming Flow

A. Flow at 7 CFM (1st Series)

Sample	Description	Flow time (min.)	Total Volume (cu. ft.)	Salt Concentration (as NaCl) (% wt/vol.)	Percent Reduction
1	Salt added, stirred 6 min.	None	None	0.490	--
2	Stirred 7 min. more	None	None	0.625	--
3	After water flow	10	75 (562 gal.)	0.208	67
4	After water flow	5	35 (262 gal.)	0.160	23

Note: The analyses of samples 1 and 2 indicate that possibly there was incomplete dissolving or non-uniform distribution of the initial charge of rock salt at the time test 3 was started. (However, sampling the bottom of the catch basin with a long handled "spoon" after sample 4 had been taken showed no undissolved salt particles.) The results of tests 3 and 4 are considered valid, as it is probable that all the salt had been dissolved and uniformly dispersed by the end of the 13 minutes stirring of test 2.

In view of the possible error the tests were recommenced, but with all salt additions made in the form of brine, i.e., the salt was predissolved in a small quantity of water and the solution added to the catch basin.

B. Flow at 7 CFM

5	Salt added, stirred 15 min.	None	None	0.610	--
6	Stirred 5 min. more	None	None	0.626	--
7	After water flow	10	76 (570 gal.)	0.165	74
8	After additional water flow	20 (additional to test 7)	143 (1070 gal.)	0.020	88
9	After additional water flow	30 (additional to test 7)	225 (1685 gal.)	0.028	--

Note: A "blank" test on the water as it came from the hydrant was made at this time. The chloride concentration (as NaCl) was found to be 0.0020 percent (probable error + 0.0004 percent).

C. Flow at 4 CFM

10	Salt added, stirred 20 min.	None	None	0.363	--
11	After water flow	20	83 (620 gal.)	0.085	77
12	After additional water flow	10 (additional to test 11)	45 (336 gal.)	0.034	60
13	Salt added, stirred 20 min.	None	None	0.304	--
14	After water flow	30	121 (905 gal.)	0.044	85

D. Flow at 1 CFM

15	Salt added, stirred 20 min.	None	None	0.887	--
16	After water flow	10	11 (82.3 gal.)	0.685	23
17	After additional water flow	30 (additional to test 11)	33 (247 gal.)	0.430	37

Volume of catch basin liquid (20 x 350 gal.) = 7000 gal.
BOD of catch basin liquid = 60 mg/l or 60 × 8.333 lb/gal. = 504 lb/million gal.
lb BOD in catch basins = 504 lb/mg × 7000 gal = 3.53 lb

$$\text{Population equivalent of catch basin liquid per storm} = \frac{3.53\ \text{lb}}{0.17\ \text{lb/person}} = 21\ \text{persons}$$

$$\text{Percent of raw sewage from area} = \frac{21\ \text{persons}}{282\ \text{persons}} = 7.5\ \text{percent}$$

If the population equivalent per storm were compared to 80 percent secondary treatment effluent:

$$PE = 7.5 \times \frac{100}{20} = 37.5$$

The BOD loading possible from catch basin liquid when the catch basin has been flushed is, therefore, seven and one-half (7-1/2) times that contained in runoff water due to street litter-water contact.

The calculated runoff through the catch basin for various sized storms based on 100 percent runoff from the catchment area is:

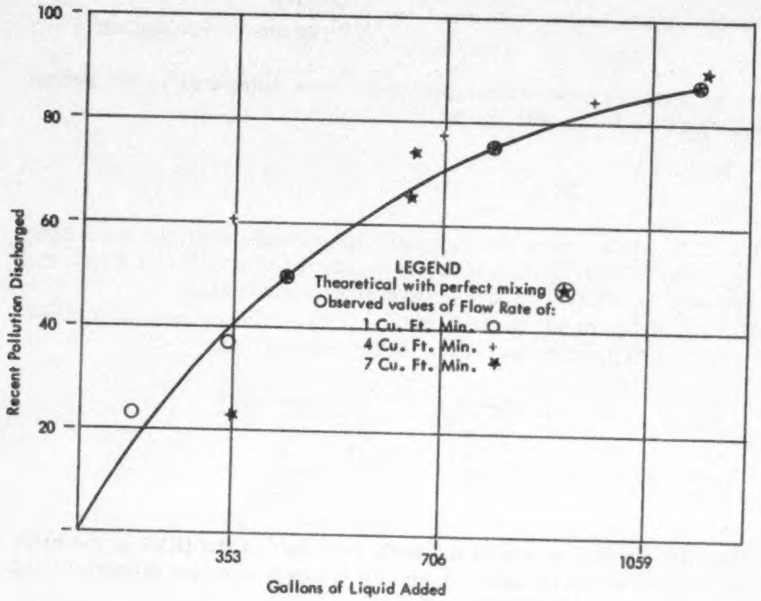
Rainfall	Gallons/catch basin
0.04	156
0.10	390
0.50	1950
1.00	3900

Thus for rainfalls as low as 0.1 inch, over half of the BOD in the catch basin liquid would be removed, and for 0.2 inch rain over 80 percent and for 0.3 inch rain, 94 percent.

The impact of this source of pollution, following the rationale developed in the analysis of the pollution potential of street litter and assuming a two-hour storm and BOD of 60 mg/l would be:

		Shock		BOD Released as a Percent of	
Amount of rain (inches)	lb BOD release catch basin	PE raw sanitary sewage	PE secondary treatment effluent	Sanitary flow	Treated flow
0.04	.093	6.6	33	65	325
0.10	.114	8.1	40	82	410
0.20	.182	12.8	64	130	650
0.30	.207	14.7	73	150	750
0.40	.218	15.4	77	157	785
0.50	.220	15.6	78	159	795

FIGURE 9. Relationship of Flow Into Catch Basin and Reduction of Concentration on Salt (NaCl)



This BOD loading on storm-water flow is in addition to the BOD acquired by the storm water on the surface. Samples were not obtained over a long enough period of time to determine the rate of increase of BOD with time in the catch basin. However, as the catch basins tested had been regularly cleaned, the weather was cool, and a relatively short period had elapsed since the preceeding rainfall, it may be assumed that the BOD used in the calculation would be at least an average and that the BOD strength would generally be higher during the warmer summer months.

The purpose of catch basins was to prevent sewer clogging caused by sand, stones, and similar materials that would settle to the bottom of the sewer. However, the quantity of sand, stone, and related materials entering catch basins has been reduced tremendously with the provision of paved streets. Nevertheless, significant quantities of organic matter continue to find their way into the catch basins in the form of leaves, grass clippings, dust and dirt, and miscellaneous substances. During periods of appreciable rainfall much of this material may be expected to stay in suspension and pass through the catch basin and into the sewer system. Some of this material remains in the basin during periods of light rainfall or in dry weather periods following street-cleaning operations. In brief, significant quantities of organic matter are lodged in catch basins, based on visual inspection and the odors that emanate from them.

There is little data as to the composition of solids retained in catch basins. The City of Winnipeg, Canada, in 1953 conducted a test of the solids in two catch basins and found:

	Percent of Catch Basin Contents	
	Number one	Number two
Moisture	39.4	43.3
Solids		
organic	3.6	4.4
cinders & sand	8.0	18.4
mud	49.0	33.9
total solids	60.6	56.7

Attempts were made during the study to obtain undisturbed samples of catch-basin solids using a-tube-within-a-tube thief device. Unfortunately, core samples could be obtained by this method from only one catch basin, a basin that was completely full of solids. In all others, the moisture content of the mixture was so high that a column of solids could not be lifted out of the basin in undisturbed condition for examination.

Cores taken from the one catch basin (one wall of which was broken) revealed that much of the solids had been washed in from under the adjoining gutter. There was almost complete classification or hydraulic sorting of the solids within the basin; those obtained from the center were composed of black, organic material, while the solids near the sides of the basin appeared to be of washed sand. Laboratory tests of the core material provided the following information:

Tests	Organic Material	Washed Sand
Total solids	58.6 %	75.2 %
Fixed solids	45.2	62.8
Volatile solids	13.3	12.4
Screen analysis		
Retained on No. 10	33.5	6.6
Retained on No. 16	7.8	1.0
Retained on No. 20	5.0	0.8
Retained on No. 30	6.1	1.4
Retained on No. 325	47.6	90.2
Specific gravities of screen fractions:		
No. 10	3.250	2.692
No. 16	3.190	3.111
No. 20	3.178	3.081
No. 30	3.220	3.130
No. 325	3.237	3.515

Catch basins containing significant quantities of organic matter act as a biological treatment unit. Indeed, the catch-basin configuration is closely akin to that of a single-cell septic tank. Three functions take place in a septic tank and might also be expected to take place in a catch basin:(9) (1) solids removal, (2) sludge and scum storage, and (3) biological decomposition. However, the catch basin would be expected to be much less efficient in accomplishing these objectives for reasons which will be outlined below.

The efficiency of any anaerobic (septic) digestion system is a function of:(10) (1) mixing, (2) solids retention time, (3) nutrient availability, (4) alkalinity, (5) loading, and (6) temperature. Biological reactions are encouraged when organisms are continuously mixed with the organic material. Since quiescent conditions exist in a catch basin during dry periods, there is little mixing. In addition, dehydration of basins during protracted dry spells would impede any biological digestion action. During rainfall periods, the entire contents of the catch basin may be agitated and flow from the basin. By comparison, the inflow to a septic tank is relatively uniform and the tank is baffled in order to prevent disturbance of the scum blanket and sludge deposit.

The solids retention in a catch basin depends on the rainfall pattern and may vary from a few minutes during a rainstorm to several months during prolonged periods of insignificant runoff.

Limited field tests were undertaken to determine the change of sludge level in a catch basin. These indicated that with a flow of 1,060 gallons in 30 minutes, the depth of sludge above the invert level was eroded 11/16 inch. The same catch basin from which the solid cores were obtained was used for this test. Visual observation indicated that the organic material tended to washout in greater proportion than the heavier sand, although the two components were still separated as previously noted.

The COD of the top layer of the solids in the catch basin was measured before and after the washing of the solids which occurred during the test. The initial COD was 38,300 mg/kg and the BOD was 1,750 mg/kg. After the test the COD was 24,900 mg/kg, a reduction of 35 percent in the top layer material.

Light storms would be expected to cause significant disturbance of the sludge deposit. This is especially true if the catch basins are cleaned infrequently. In such cases, the catch basin would supply a smaller initial flushout of polluted liquid. However, the subsequent resuspension of sludge solids would serve as a continuing source of pollution during the rainfall, caused by the elutriation of organics from the disturbed and resettled heavy sludge solids, or by the actual washout of the sludge itself.

The catch basin is a poor sedimentation device. The University of Illinois study indicates that catch basins are prone to resuspend the solids in the sludge deposits even at moderate inflow rates.(7 8) Attempts by the University group to baffle a catch basin to improve settling showed additional adverse effects.

All in all, it can be concluded that catch basins cannot satisfy efficiently the competing objectives of good hydraulic characteristics and solids retention. If solids retention is desired then it appears that a facility for that specific purpose—or a dual-purpose facility to also store flows to reduce the rate of flow should be incorporated as part of the sewer system.

The difference in sizes of catch basins could explain the variance that has been observed in overflow pollutant-concentration time. In cities with large catch basins, the length of time for the flushing effect would be longer. Conversely, cities with smaller catch basins would be expected to have a more uniform concentration of pollutants due to the shorter time of discharge of the basin water in this first flush, and then the subsequent discharge of resuspended sludge bed solids.

Field Test of Storm-Water Runoff

An attempt was made to correlate the amount and strength of pollution of street litter with the pollution in storm-water runoff as it reached a catch basin. A mobile sampling trailer (described in the following section, chemicals) was placed adjacent to a catch basin in a residential neighborhood on the north side of the city. The City of Chicago has done extensive research in rainfall-runoff relationships in this immediate area. A recording rain gauge and a flow meter on the combined sewer are both in place and connected to the Public Works Department office in downtown Chicago.

Samples were obtained by placing a 10-gallon receptacle on a stand within the catch basin so that the lip of the receptacle was six inches under the grate on the catch basin. Plastic was used around the curb side of the inlet to funnel runoff into the receptacle. A screen was placed over the receptacle to strain out leaves and vegetation and a siphon was constructed within the receptacle to aid in obtaining at any one time a representative sample.

The sample controls were activated upon the collection of 0.04 inches of rainfall in a 12 × 12 inch pan, concentrated in a 2 × 3 inch receiving basin.

Throughout the tests, mechanical failures of various types occurred. Insufficient samples were obtained to determine relationships between the amount of street litter and the pollution of storm-water runoff with time and intensity of precipitation.

The following laboratory results were obtained from samples collected during the testing period.

Date		Time From Beginning of Runoff	Plate Count (Colonies/ml)	Coliform organism (confirmed MPN/ 100 ml)	Fecal Enter-cocci (con-firmed MPN/ 100 ml)
July	26	0	120,000	70,000	240
"	26	5 Min.	94,000	49,000	0
Aug.	1	0	250	23	0
"	1	15 Min.	670	240	23
"	3	0	240	240	23

Date		Time	BOD mg/l	COD mg/l	pH	Total Nitrogen (as N-mg/l)	Total Phosphate (as PO_4-mg/l)	Dissol-ved Sol-ids mg/l
Sept.	20	5 Min.	185	588	7.3	7.50	0.40	--
"	20	15 Min.	90	216	7.[illegible]	6.60	0.10	--
"	20	25 Min.	20	59	7.3	9.70	0.80	--
"	20	Composite 30-60 Min.	65	267	7.6	10.00	4.40	228
"	20	Composite 70-130 Min.	40	114	6.8	4.60	2.80	141

Throughout the testing period, large amounts of leaves restricted the operation by their presence in the sampling receptacle. On November 3, leaves from the area, primarily oak and elm, were sampled by macerating them to a puree for 10 minutes in a Waring blender, using 100 ml of distilled water/5g of leaves. The 20-day BOD and COD of the supernatant liquor were:

20 Day BOD = 25.4 mg/g of sample
20 Day COD = 26.9 mg/g of sample

Thus the presence of vegetation, and leaves in particular, could exert a strong BOD load when allowed to decompose in a catch basin or in standing water in the street gutter.

Summary

Catch basins may be one of the most important single sources of pollution from storm-water flows. Tests of catch basins indicates that the stagnant pool of water in the basins is polluted. For Chicago catch basins the maximum sump depth is 54 inches, providing the basins when cleaned are completely emptied. Based on averages for the entire city the depth of the sludge deposit when cleaned would be about nine inches as indicated in Table 18, Trends in Catch Basin Cleaning Practices; the expected depth of the sludge deposit is only four to five inches for Chicago catch basins. Consequently, it would be expected that light storms would not cause significant disturbance of this sludge deposit so the majority of the pollution from these catch basins can be attributed to the first flush of the runoff. However, practice seems to vary between complete cleaning and removal to only 24 inches below the outlet pipe invert. Because the data reflects average values, some catch basins in critical locations, such as near the beach or at underpasses, may be cleaned very frequently and catch basins in other areas may receive infrequent cleaning.

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TABLE 18. Trends in Catch Basin Cleaning Practices, Chicago
(Cu Yds of Material Removed/Catch Basin)

Year	Number of Catch Basins in Place in 1000's	Method of Catch-Basin Cleaning												Annual Fre-quency	Annual Cubic Yard/ Catch Basin
		Hand			Eductor			Orange Peel			Total				
		Number Cleaned in 1000's	Cubic Yard in 1000's	Cubic Yard/ Catch Basin	Number Cleaned in 1000's	Cubic Yard in 1000's	Cubic Yard/ Catch Basin	Number Cleaned in 1000's	Cubic Yard in 1000's	Cubic Yard/ Catch Basin	Number Cleaned in 1000's	Cubic Yard in 1000's	Cubic Yard/ Catch Basin		
1947	187.	165	.50	82	43	34	.79	0	0	-	198	116	.59	1.11	.66
1949	188.	210	.48	101	52	39	.75	0	0	-	262	140	.53	1.39	.74
1950	188.	147	.50	73	50	38	.74	0	0	-	197	111	.56	1.05	.59
1951	188.5	158	.50	79	50	36	.72	0	0	-	208	115	.55	1.10	.60
1952	189.	254	.33	84	51	37	.73	0	0	-	305	121	.40	1.61	.64
1959	197.5	338	.29	97	90	44	.49	66	33	.50	494	174	.35	2.50	.87
1960	200.5	339	.29	99	91	44	.48	75	35	.47	505	178	.35	2.50	.87

Chemicals

Some forms of urban storm water runoff pollution occur as the result of man's deliberate efforts to solve other pressing environment problems. Increasing use of chemicals for control purposes offers a case in point. Such purposes include: (1) control of snow and ice on streets and highways, (2) prevention of corrosion from chemicals used for snow and ice control, and (3) use of pesticides, herbicides, and fertilizers to control unwanted insect infestations or to aid and stimulate plant and other vegetative growths.

Pollution from the above listed sources is of relatively recent origin. The use of salt (sodium chloride) and calcium chloride for snow and ice control is a recent innovation in governmental practice. The need for corrosion-prevention additives followed the use of salt. The market for pesticides, herbicides, other chemical inhibitors and for fertilizer used by government and local residents has expanded rapidly with the increased urbanization following World War II.

Salt and Calcium Chloride

The two chemicals which public jurisdictions have come to rely upon in very recent years for control of snow and ice are salt and calcium chloride. Salt is very effective in melting snow, preventing icing conditions, and breaking the bond between the pavement and the snow at temperatures down to about 20°F. However, many jurisdictions find salt effective to 5 to 10°F where there are large volumes of fast traffic. Calcium chloride is generally used alone at temperatures below 10°F and in the temperature range of 10 to 20° F a combination of sodium and calcium chloride is often used.

Use of these chemicals has replaced the widespread use of sand and cinders, and it has supplanted the plowing of light snow. Their use has had a demonstrable effect in reducing accidents and public inconvenience. The Salt Institute estimates that salt use has increased each year during the period 1961 to 1965. ([1]) For the winter of 1964 to 1965 it is estimated that 5,000,000 tons of salt were used by all agencies for snow and ice control. Of this total, one million tons were used directly by cities; state highway departments, counties and toll-road authorities used 3,600,000 tons—a portion of which was used within urban areas. The use of calcium chloride averages about five percent of the weight of salt used.

Typical applications of salt vary from 100 pounds to 2,000 pounds per lane mile. The average single application is from 200 to 400 pounds per lane mile. During a winter season several states apply as much as 20 tons per lane mile. Toll road authorities appear to be using the greatest applications.

Runoff containing these chemicals has had an effect upon the immediate environs. Thirteen states have reported damage to vegetation and twelve states have reported pollution caused by chemical intrusion into surface and ground water sources. ([2])

Street trees in the City of Chicago are reported to have been killed or stunted by the effects of salt. A great deal of research on the effects of salt on trees and grasses has been conducted to identify salt-resistant or salt-tolerant strains which may be used in areas subject to snow-melt runoff. The Department of Agronomy, Virginia Polytechnic Institute, currently has a project underway for the National Cooperative Research Program, Highway Research Board, National Academy of Science-National Research Council. ([2])

In addition to their effects on plants, there is increasing evidence that salt is changing the aquatic environment of small lakes that receive highway drainage. A study by the Wisconsin Committee on Water Pollution ([3]) reports that three lakes near Madison where the known sources of the inlet waters had not been altered have experienced a four to eight-fold buildup in salt concentration although the concentration at this time has still not reached dangerous levels. John A. Judd ([4]) has reported on the changes in the ecology of a lake located in Ann Arbor, Michigan. The disappearance of bottom organisms and changes in the benthic population may significantly reduce the ability of the lake to recover from temperature overturns resulting in reduction in oxygen levels.

During the winter of 1966 to 1967, field investigations were made to determine the chloride content of the storm-water discharge from a section of the Kennedy Expressway in downtown Chicago. The drainage is sharply defined and excellent controls were available to ensure that only water from the specific area was sampled. The total area was 101.8 acres, including 52 acres of impervious terrain. All discharges were pumped from the highway sewer collection system to an intercepting sewer of the Metropolitan Sanitary Sewer District of Greater Chicago.

To obtain the runoff samples, a mobile sampling trailer, developed at the Robert A. Taft Sanitary Engineering Center was used. The sampler permitted the collection of up to 72 one-gallon samples, taken at controllable time intervals. Samples were taken from a wet well in which two 350-gpm sump pumps are located. A sample was taken each time approximately 3,000 gallons of liquid had accumulated in the sump. If there was continuous flow an additional sample was taken each half hour.

Individual samples were composited daily for laboratory analyses. Separate hourly samples were taken when possible during periods of salting.

This section of the expressway is maintained by the Illinois Division of Highways. In the winter of 1966 to 1967, approximately 17.6 tons of salt per lane mile were used. This amount does not include the quantities of salt used during the major snow of January 26 when records were not maintained. The usual individual application was 200 pounds per lane mile. The testing program began February 16 and was completed April 1. During the period February 16 to April 1, 14.1 inches of snow fell and 126 tons of salt were used in the test area. Equipment failures invalidated the information obtained from February 16 to February 23, a period when 76 tons of salt were used. Except for periods of the most severe temperatures, an infiltration flow of at least 45 gpm was experienced.

During periods when salting was not conducted, the chloride concentration ranged from 1,900 to 4,500 ppm, with an average of about 2,000 ppm. Flows during this period were as high as 0.3 cfs. During periods of snowfall, chloride concentrations of 11,000 to 25,000 ppm were found, with an average of about 14,000 ppm. Flow varied from 0.1 to 1.5 cfs.

From Table 19, Analyses of Flow, Salt Applied, and Salt Discharged, Kennedy Expressway February 23 to April 1, 1967, it may be noted that for the period February 24 to April 1, 101,600 pounds of salt were applied and that 105,800 pounds of salt were discharged. (a) The results are shown graphically in Figure 10, Salt Applied as Compared to Salt Discharged, Kennedy Expressway, February 24 - April 1, 1967. Previous studies on highway runoff have indicated that only one-half of the salt applied was discharged. In this urban area it appears that salt recovery is very high.

Associated with the use of salt for snow and ice control is the use of ferric ferrocyanide (prussian blue), which is added to salt to prevent caking. Prussian blue is insoluble in water and thus does not contribute to pollution. However, some jurisdictions have also used sodium ferrocyanide (yellow prussiate of potash). This compound notably is soluble in water but releases cyanide in the presence of sunlight.

Another problem that has accompanied the necessary use of salt is accelerated corrosion of vehicles. Two chemical additives have been marketed to reduce the corrosion effects of salt. To date, there has been limited use of these chemicals because of the extra cost, a lack of reliable statistical evidence that corrosion is reduced, and the lack of agreement of adjacent jurisdictions to use the material. For several years a sodium hexametaphosphate material has been used by some jurisdictions. However, its phosphate content acts as a nutrient in receiving waters and thus contributes to pollution by speeding eutrophication.

In recent years a sodium chromate product, employing a hexavalent form of chromium has been used by some jurisdictions. Hexavalent chromium is toxic, and its presence in water used for drinking is limited to 0.05 mg/l. Field tests were conducted in Harvey, Illinois, in February, 1967 to determine the concentration of hexavelent chromium in the melted snow along the gutter. Concentrations of less than 0.01 mg/l were found.

During the course of another research project being directed by the APWA in Minneapolis, Minnesota to determine the effectiveness of sodium chromate as a corrosion inhibitor, samples of gutter water and slush were analyzed. Concentrations of hexavalent chromium ranging from 0.1 to 116 mg/l were found. During extensive testing of the product in Minneapolis and Hennepin County in earlier years, the highest concentration of hexavalent chromium found was 1.689 mg/l in the receiving stream. ([5])

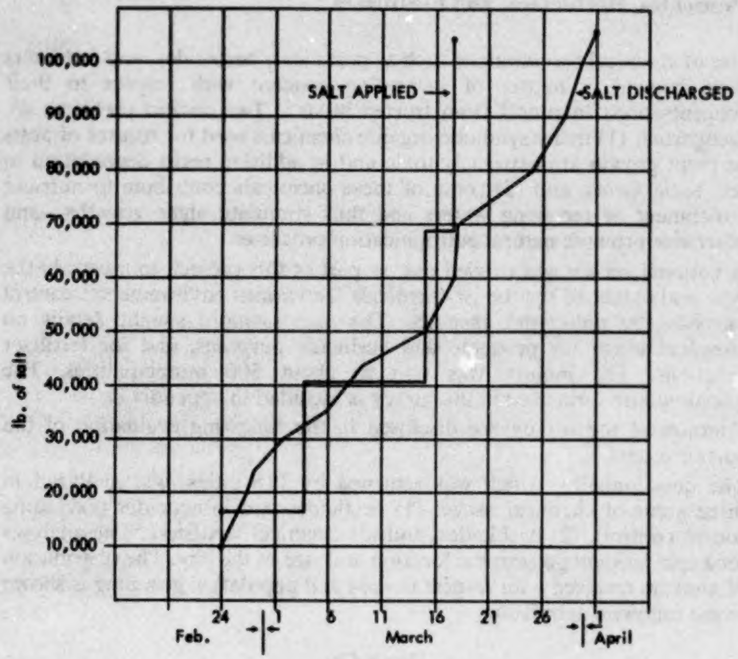
In addition to salt, other chemicals have been used to melt snow and ice. The primary ingredient in these compounds are urea and ammonia nitrate.

(a)Some of the salt applied prior to February 24 was discharged during this runoff period.

TABLE 19. Analysis of Flow, Salt Applied, and Salt Discharged
John F. Kennedy Expressway, February 23 to April 6, 1967

Date	Daily Flow (gal.)	Average Chloride Concentration (ppm)	Salt Applied (lbs.)	Total Salt Applied (lbs.)	Salt Discharged (lbs.)	Total Salt Discharged (lbs.)
2/23	28,080					
24	30,660	25,100	16,100	16,100	10,400	10,400
25	41,040	6,900	-	-	3,840	14,240
26	45,800	6,900	-	-	4,280	18,520
27	59,850	6,900	-	-	5,600	24,120
28	55,600	3,400	-	-	2,560	26,680
3/1	42,800	2,700	-	-	1,570	28,250
2	33,050	3,000	-	-	1,340	29,590
3	44,640	1,900	-	-	1,150	30,740
4	39,000	2,700	24,200	40,300	1,430	32,170
5	38,780	2,700	-	-	1,430	33,600
6	37,200	4,250	-	-	2,140	35,740
7	22,600	4,350	-	-	1,330	37,070
8	20,700	4,100	-	-	1,150	38,220
9	31,310	3,250	-	-	1,380	39,600
10	57,660	2,100	-	-	1,640	41,240
11	76,200	2,040	-	-	2,110	43,350
12	43,400	2,040	-	-	1,200	44,550
13	69,160	2,040	-	-	1,920	46,470
14	44,100	2,398	-	-	1,430	47,900
15	54,180	9,970	29,100	69,400	9,490	52,390
16	26,550	4,030	-	-	1,450	53,840
17	27,800	4,870	-	-	1,830	55,670
18	17,400	4,920	-	-	1,160	56,830
19	15,700	4,920	32,200	101,600	1,050	57,880
20	193,750	4,920	-	-	12,900	70,780
21	105,300	1,800	-	-	2,570	73,350
22	44,640	2,750	-	-	1,660	75,010
23	44,640	1,420	-	-	850	75,860
24	77,800	2,300	-	-	2,430	78,290
25	44,640	2,660	-	-	1,600	79,890
26	46,000	2,170	-	-	1,350	81,240
27	159,500	2,300	-	-	4,970	86,210
28	41,000	2,300	-	-	1,280	87,490
29	25,400	2,435	-	-	840	88,330
30	25,000	2,485	-	-	840	89,170
31	186,200	2,085	-	-	5,250	94,420
4/1	1,001,550	350	-	-	4,700	99,120
2	171,900	350	-	-	810	99,930
3	380,500	350	-	-	1,800	101,730
4	45,000	1,795	-	-	1,100	102,830
5	46,000	1,995	-	-	1,240	104,070
6	41,000	1,995	-	-	1,110	105,180

FIGURE 10. Salt Applied as Compared to Salt Discharged, Kennedy Expressway Feb. 24- April 1, 1967



Both of these act as nutrients in receiving bodies of water. Use of such chemicals is common on airports because salt is corrosive to airplanes.

In recent years the sale of products to individual homeowners for use on sidewalks has greatly increased. Calcium chloride is the principal household chemical, although ammonium nitrate and potassium pyrophosphate compounds are also sold. While these are used, it can be expected that receiving waters will be affected by them during periods of snow melt.

Pesticides, Herbicides, and Fertilizers

Use of chemical formulations such as pesticides, herbicides, and fertilizers have become a matter of increasing concern with respect to their concentrations in runoff from treated areas. Two distinct problems are recognized: (1) many synthetic organic chemicals used for control of pests or plant growth are extremely toxic and in addition resist degradation to less toxic forms, and (2) some of these chemicals contribute to nutrient enrichment of receiving waters and thus stimulate algae growths—and otherwise promote natural eutrophication processes.

A national survey was carried out, as part of this project, to ascertain the type and extent of the use of chemicals for various environmental control purposes by municipal agencies. The questionnaire sought details on chemical usage for pesticide and herbicide purposes, and for fertilizer functions. The inquiry was sent to about 500 municipalities. The questionnaire form used in the survey is included in appendix D.

Findings of the survey are disclosed in the following evaluation of the pertinent data.

The questionnaire, which was returned by 118 cities, was analyzed in three areas of chemical usage: (1) pesticides and insecticides (excluding rodent control), (2) herbicides, and (3) chemical fertilizers. The analyses took into account geographic location and size of the city. The distribution of answers received with respect to area and population grouping is shown in the following tabulation.

	Size of City					
Part of Country	0-10,000	10,001-25,000	25,001-100,000	100,001-1,000,000	Over 1,000,001	Total
East	0	7	17	10	1	35
South	0	4	8	3	0	15
Midwest	0	9	15	3	1	28
Southwest	0	1	4	6	0	11
West	0	6	15	8	0	29
TOTAL	0	27	59	30	2	118

Almost 90 percent of the cities responding to the questionnaire reported the use of chemicals to control pests and insects. While the use of a great variety of chemicals was reported, only four were found to be used with any regularity throughout the country. The four—carbaryl (sevin), chlorodene, DDT, and melathion—were reportedly used in from 21 to 49 percent of the cities, depending upon city size. For details see Table 20, Use of Pesticides and Insectcides.

The tabulated chart indicates that there is great variation in use of certain type of chemicals depending upon geographic location. Melathion, the most commonly used pesticide, is used by 66 percent of the cities in the Far West, but only 37 percent of the cities in the Midwest. The East and the Midwest reported the use of DDT more frequently than in other parts of the country. However, only seven percent of the cities in the Midwest used chlorodene and the same percentage used carbaryl. In comparison, 45 percent of the cities in the Southwest and 37 percent of the cities in the East used chlorodene and carbaryl respectively. The percentage of cities using pesticides increases with increasing city size.

Trends of future pesticide and insecticide may be gauged by the fact that the reporting cities planned to either increase or continue similar use of over two-thirds of the chemicals presently used, while an expected decrease in usage was reported for only eight percent of the chemicals now used. Nearly 90 percent of the reporting cities used pesticides on public lands, 43 percent of the cities on parkways, and slightly over 10 percent on private lands.

Herbicides

Use of herbicides was reported by nearly 85 percent of the cities responding to the questionnaire. In contrast to the pesticides situations where little difference could be noted in their use by either size of city or geographic location, a fairly wide geographic variation in the use of herbicides was found. Nearly 30 percent of the cities in the Midwest and 23 percent of those in the East stated they did not use herbicides, contrasted with less than ten percent of the remaining cities.

Of the many chemicals listed, only one received widespread usage as a herbicide throughout the country. Over 50 percent of the cities reported the use of 2, 4D as part of their program to inhibit unwanted plant growth. The percentage of cities using 2, 4D varied from 33 percent in the South to 64 percent in the Southwest. Usage also increased with increasing city size. Cities reported that 45 percent of the herbicides presently used would receive increased usage in the future and only 10 percent decreased usage.

TABLE 20. Use of Pesticides and Insecticides

	Future Planned Use				Where Used		
City Size	No. Using	Increased	Same	Decreased	Parkway	Public Land	Private Land
			Carbaryl (Sevin)				
0-10,000	-	-	-	-	-	-	-
10,001-25,000	3	1	2	-	3	2	-
25,001-100,000	11	3	4	1	5	9	1
100,001-1,000,000	10	5	3	1	6	8	1
Over 1,000,000	1	-	-	-	1	1	-
TOTAL	25	9	9	2	15	20	2
Geographic Location							
East	13	3	6	2	8	10	1
South	1	1	-	-	1	1	-
Midwest	2	1	1	-	1	2	1
Southwest	1	1	-	-	1	-	-
West	8	3	2	-	4	7	1
			Chlordane				
City Size							
0-10,000	-	-	-	-	-	-	-
10,001-25,000	3	1	2	-	2	1	-
25,001-100,000	17	4	7	2	5	15	3
100,001-1,000,000	9	5	3	2	3	7	1
Over 1,000,000	1	-	-	-	-	1	-
TOTAL	30	10	12	4	10	24	4
Geographic Location							
East	9	3	4	-	-	8	2
South	5	-	3	1	4	1	-
Midwest	2	-	-	1	-	2	-
Southwest	5	3	1	1	2	5	-
West	9	3	4	1	4	8	2
			DDT				
City Size							
0-10,000	-	-	-	-	-	-	-
10,001-25,000	6	3	2	-	4	6	2
25,001-100,000	19	4	7	4	9	18	3
100,001-1,000,000	14	3	5	1	9	12	2
Over 1,000,000	2	1	1	-	2	2	-
TOTAL	41	11	15	5	24	38	7
Geographic Location							
East	15	1	8	4	6	14	3
South	2	1	-	-	1	2	-
Midwest	12	4	4	1	9	11	2
Southwest	3	1	1	-	2	3	1
West	9	4	3	-	6	8	-
			Malathion				
City Size							
0-10,000	-	-	-	-	-	-	-
10,001-25,000	12	5	5	-	9	11	3
25,001-100,000	27	15	7	1	12	25	3
100,001-1,000,000	18	6	8	-	8	15	3
Over 1,000,000	1	-	1	-	1	-	1
TOTAL	58	26	21	1	30	51	10
Geographic Location							
East	14	5	7	-	7	10	3
South	8	3	3	-	2	7	-
Midwest	11	4	3	-	5	10	4
Southwest	6	3	2	-	3	6	1
West	19	11	6	1	12	18	2

Fertilizers

Use of chemical fertilizers was reported by 80 percent of the cities surveyed. However, their use varied from over 90 percent of the cities in the Far West to less than 70 percent of the cities in the Midwest; from 60 percent of the cities with populations of less than 25,000 to almost 90 percent of the cities with populations of greater than 100,000.

Fertilizers are generally purchased on the basis of their plant-nutrient content, which is referred to by the name of the formulation. These formulation numbers specify the percentage of nitrogen (N), phosphate (P_2O_5), and potash (K_2O), in that order, contained in the fertilizer. (For example, a 4-12-4 fertilizer would contain 4% N, 12% P_2O_5, and 4% K_2O, and would have a plant-nutrient content equal to the sum of those figures, or 20 percent.) The purchase of fertilizers with higher concentrations of plant nutrients decreases the volume of fertilizer which must be purchased to obtain the desired nutrient value for the land being covered. For this reason, it was felt that evaluations of the use of fertilizers could not be done simply on the basis of product or amount used.

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Air Pollution

The three pollution-causing interfaces have been defined in this study report as air, ground surface, and the storm water drainage facility. In this section, sources of pollution at the air interface will be considered.

Air pollution is a source of storm-water pollution that cannot be ignored in evaluating the composition of runoff. Control of air pollution may also result in water pollution and thus add to the polluting effects of combined sewer overflows.

General

Air contaminants exist in the form of particulates (aerosols) and gases. A substantial amount of air pollution is of natural origin—weathering, dust storms, forest fires, volcanic eruptions—and is relatively uncontrollable. In most communities, however, the significant harmful air pollution is manmade—resulting from mining, refining, manufacturing, incineration, construction, and combustion of fuels for power production, heating, and automotive power. It is largely controllable by improved design, operation, and maintenance of equipment for which proper technology now exists. Although the cost of control equipment varies from a fraction up to 100 percent of that of the process equipment, this cost can be offset in some cases by the value of the products reclaimed or salvaged from the raw gas emissions, or through improved combustion efficiencies.

The U.S. Public Health Service has identified five principal categories of air pollutants: carbon monoxide, sulfur oxide, nitrogen oxide, hydrocarbons, and particulate matter. Table 21 lists for the United States the estimated contribution in millions of tons of air pollutants from motor vehicles, industry, power plants, space heating, and refuse disposal. Motor vehicles, industry, and power plants are the largest sources of pollution. Industry is estimated to contribute one-half of the particulates.

TABLE 21. Annual Emissions of Air Pollution Constituents

	Carbon Monoxide	Sulfur Oxides	Nitrogen Oxides	Hydro-carbons	Particulate Matter
	(in millions of tons)				
Motor Vehicles	66	1	6	12	1
Industry	2	9	2	4	6
Power Plants	1	12	3	1	3
Space Heating	2	3	1	1	1
Refuse Disposal	1	1	1	1	1

Source: U.S.P.H.S.

Dustfalls

Particulates are minute separate particles (aerosols) of matter or liquid varying in size from 0.1 to 100 microns or larger (1 micron = 1/25,400 in.). Relatively heavy particles settle out readily at varying distances from the source of emission to the atmosphere depending on their size, specific gravity, and climatic conditions. To illustrate, the approximate settling rates of spherical particulates with specific gravity of one (1) are:

a. Particulates less than 1 micron in size have a rate of settlement ranging from 0.0 to 0.1 feet per minute and consequently remain more or less permanently in the atmosphere.
b. Particulates varying from 1 to 100 microns in size have a rate of settlement ranging from .01 to 100 feet per minute and stay only temporarily in the atmosphere. These particulates form the bulk of suspended solids.
c. Particulates above 100 microns in size have a rate of settlement ranging from 100 to 1000 feet per minute. Consequently they settle out readily at varying distances from point of emission, depending on wind velocities and other atmospheric conditions. These are the particulates that comprise dustfalls.

Total annual dustfall in urban areas ranges from 500 to 900 tons per square mile. Present air-quality objectives call for a range varying from 120 for rural areas to 700 for heavy industrialized areas. Dustfalls are of concern mostly because of their potential injury to property, and their effect on human comfort and convenience. However, intermittent flushing of dustfall into storm and combined sewers and surface waters lays claim for concern because of its potential injurious effect and the necessary attendant costs it may impose for removal by treatment processes.

Suspended Solids

As previously noted, particles finer than 10 microns normally stay in suspension unless they increase in weight and size by agglomeration or electrostatic attraction and thus precipitate as dustfall, unless they are washed out (scavenged) by rain, snow, or ice precipitation. Particulates removed below the clouds are termed "washouts" and are carried out mostly by the inertial impact action of rain and snow droplets which range in size from 0.1 to 3.0 mm. in diameter. Particles removed from within the clouds are termed "rainouts" and are carried out mostly by electrostatic effects and by nucleation.

Findings from the National Air Sampling Network (NASN) in more than 300 cities indicate that the concentration of suspended particulates has been slowly decreasing from a mean in 1957 of 120 to a low in 1963 of 100 micrograms per cubic meter. Their organic content approximated seven percent by weight. Present air-quality objectives call for a range from 40 for rural areas to about 100 for heavily industrialized areas. Although suspended particulates comprise only about one percent by weight of the six major gaseous pollutants, they are significant because of their potential impact on health. They act as a vehicle for transmitting absorbed toxic gases into lungs and other vulnerable parts of the body.

Noxious Gases

The six major gaseous pollutants are sulfur dioxide, nitric oxide, nitrogen dioxide, total hydrocarbons, carbon monoxide, and total oxidant. Although less obvious than dust, smoke, and fly ash, the impact of these gaseous pollutants on vegetation and animal life can be more injurious and far-reaching. Scavenging of these gases by rain and ice precipitation is a process of molecular diffusion of the gas to the water or ice surface. The washout coefficient (fraction washed out per unit of time) for gases is directly proportional to the rate of rainfall. These washed-out gases also create pollution of storm-water runoff.

Composition of Suspended Solids

A summary analysis of 17,608 samples (14,494 urban and 3,114 nonurban) collected during 1957 to 1961 by the National Air Sampling Network is shown in Table 22, Mean and Maximum Concentration of Selected Particulate Contaminants.

Air Pollution Abatement Equipment

Particulate matter can be removed by filtration, precipitation, wash-water entrainment, or centrifugal force. Gaseous substances can be removed by liquid scrubbing, vapor recovery, combustion, and absorption.

The liquid wastes from water-using control processes, such as wet-bottom subsidence chambers and from scrubbers, both commonly used on pollution abatement equipment, is a potential source of pollution. Discharge of such contaminated waters into storm or combined sewers further degrades the quality of storm-water discharges or overflows. Local regulations on sewer use, if enforced, will dictate the methods used for the treatment, and/or reclamation of such air pollution control waste waters, and their points of disposal.

Relationship Between Air-Pollution Control and Urban Water Pollution Potential

The 1967 Clean Air Act provides additional impetus to the installation of air-pollution control devices. Installations that use water in the control process could add to the pollutional characteristics and volumes of flow in combined sewers. Without adequate in-house treatment, discharge of the

TABLE 22. Minimum and Maximum Concentrations of Selected Particulate Contaminants

1957 to 1961

(Micrograms per cubic meter)

	Urban		Nonurban	
	Mean	Maximum	Mean	Maximum
Suspended particulates	104	1706	27	461
Benzene-soluble organics. . .	7.6	123.9	1.5	23.55
Nitrates	1.7	24.8	. . . .	. . . .
Sulfates.	9.6	94.0	. . . .	. . . .
Antimony	(a)	0.230	. . . .	. . . .
Bismuth	(a)	0.032	. . . .	. . . .
Cadmium	(a)	0.170	. . . .	. . . .
Chromium.	0.020	0.998	. . . .	. . . .
Cobalt	(a)	0.003	. . . .	. . . .
Copper	0.04	2.50	. . . .	. . . .
Iron.	1.5	45.0	. . . .	. . . .
Lead	0.6	6.3	. . . .	. . . .
Manganese	0.04	2.60	. . . .	. . . .
Molybdenum	(a)	0.34	. . . .	. . . .
Nickel	0.028	0.830	. . . .	. . . .
Tin	0.03	1.00	. . . .	. . . .
Titanium	0.03	1.14	. . . .	. . . .
Vanadium.	(a)	1.200	. . . .	. . . .
Zinc	0.01	8.40	. . . .	. . . .
Radioactivity	[b]4.6	[b]5435.0	. . . .	. . . .

a. Less than minimum detectable quantity.

b. Picocuries per cubic meter.

flows to other sewer systems would also result in pollution of receiving bodies.

Industrial-waste disposal and sewer use ordinances of a municipality should propose limitations on the effluent quality of such discharges. In addition, it appears desirable to establish service charges for handling such discharges on the basis of quantity and quality of effluents. The value of reclaiming and reusing water and byproducts merits consideration.

Specific Examination of the Problem

Two efforts were made to add greater specificity to the general information available on the impact of air pollution on the water-pollution potentials of urban environment wastes. These two efforts were planned as:

1. A survey of manufacturers of air pollution control equipment to ascertain from them the practices of users of their processes and products in eliminating aerial discharges and in preventing water pollution caused by the discharge of waste waters to public sewers from stack scrubbing and other water-using operations.
2. A survey of typical industrial and commercial operations in a "typical" community—Chicago, Illinois—to determine in actual practice what water-using operations are employed for air pollution control purposes and the methods used for disposal of their waste waters.

Information of this nature was not found, with any specificity which could be translated into water pollution potential of urban environmental wastes, despite an earnest search of available literature on air pollution control practices. It must be recorded at the outset that efforts to consummate these two phases of research were not successful. However, the rationale for the two-faceted study and the means outlined for approaching these fact-finding tasks are placed on record in this report. They point to the need for a more detailed and intensive effort to uncover information of this nature.

The current commitment to improve air pollution control on national, state, interstate, and local levels will lead to increased cleansing of airborne emissions. This effort could result in an increase in water-pollution at a time when preservation of the nation's water resources is a matter of major concern.

The fact is there is little reliable information available on the relationship between water based air pollution control devices and water pollution resulting from the disposal of waste waters produced by such operations. While impact on water pollution may be small, nevertheless it should be evaluated particularly in terms of the increased large volumes of flow that may be introduced into combined sewers and thus increase the number of overflow incidents and their duration.

Manufacturers' Survey

During January, 1968 an effort was made to obtain from leading manufacturer of air pollution control equipment information on the use of water-based facilities and the extent of treatment and reuse of such spent waters prior to disposal into sewers or water course. Six manufacturers submitted pertinent catalogs and bulletins on this subject, and additional data were made available for study from other sources. In general, the manufacturers could supply little or no information on what treatment is given waste waters from stack-cleansing operations by the purchasers and users of their equipment and processes. It was their view that their responsibility and authority ended with the proper and effective application, installation and operation of the facilities they supplied.

However, a number of manufacturers pointed out that they offered their customers water treatment equipment for the purpose of purifying stack waste waters and reusing these waters and reclaiming any intercepted end-products of stack washing operations.

This "dead-end" dearth of information from manufacturers' sources has emphasized the need for a specific study of water-using industrial air pollution control measures by representative industries.

Survey of Industry Practices

To meet this need, the project study made an effort to obtain the specific industry information referred to above. However, the help of governmental agencies involved in regulating sewer connections was deemed necessary. At a meting with representatives of The Metropolitan Sanitary District of Greater Chicago and the Department of Air Pollution Control, City of Chicago it was learned that:

1. Inasmuch as combined sewers are used, all wastes are allowed into the sewers, namely no effect is made to separate "clean" wastes from the flow requiring treatment
2. No records are available as to which industries have in-house treatment facilities for discharges from air pollution control operations
3. Industrial plants do not separate their waste systems as there is no direct charge for the treatment of wastes based on volume or strength
4. Where water is used in air pollution control devices either process water or "clean" water is used and most systems are "closed" without a suitable spot for obtaining samples, and
5. Departmental policy would not make cooperation possible in finding locations which might readily be sampled. No authorization exists for the city to sample such waste streams and the policies of the sanitary district are to sample only at the sewer connection and not to publish any data which would identify products or processes conducted by the industry.

It was therefore determined that within the resources of the present project, the study could not be undertaken.

The Sewer System

Storm water in built-up urban areas usually is transported by an underground conduit from a curb inlet to the point of disposal in a receiving body. In this process, storm water may be further polluted by the nature of the conduit or by the maintenance practices and rules and regulations of the local jurisdiction.

Storm water in combined sewers will mix with the normal flow of sanitary sewage and transport previously deposited solids. Combined sewers and combined sewer regulators must be adequately maintained, or needless pollution will occur during combined sewer overflows. The buildup of shoaled solids during periods of dry weather can result in concentrated discharges as soon as storm flows produce hydraulic surges.

Any materials introduced in either storm or combined sewers as a result of inadequate regulations of the governmental jurisdiction will magnify this pollution condition.

Effect of Grit Deposition and Sewer Cleaning

It is again stated that the primary purpose of catch basins is to prevent sewer clogging. A group at the Johns Hopkins University conducted an extensive study of the causes of sewer clogging in sanitary lines. Based on detailed data for several cities, the report concluded that the major cause of sewer clogging is root penetration.(1) Accumulation of debris in the absence of roots was found to be most prevalent in the upper reaches of the sewer system, and little clogging was found in sewers larger than 15 inches in diameter.

The causes of deposition in an eight inch sanitary sewer were investigated by Raths and McCauley.(2) They concluded that deposition is not induced by the suspended solids in sewage. Furthermore, pipe joints, not sewer slope, were the principal factors in causing deposition.

Table 23, Trends in Combined Sewer Cleaning Practices, Chicago, summarizes 10 years of sewer cleaning records which provide an insight into maintenance practices in combined systems. It is shown that the frequency of sewer scraping ranges from six to ten years. Flushing of the upper reaches of sewers is done every four to eight months. Analysis of the quantity of solids removed during sewer scraping indicates an average of about 5.0 cubic yards removed per sewer mile scraped.

TABLE 23. Trends in Combined Sewer Cleaning Practices, Chicago

Year	Miles of Sewers	Miles Cleaned per Year		Annual Cleaning Frequency	
		Scraping	Flushing	Scraping	Flushing
1946	3495	430	5,200	.120	1.50
1947	3500	445	5,300	.130	1.50
1948	3505	450	5,500	.135	1.55
1949	3510	480	5,500	.135	1.55
1950	3525	403	4,500	.115	1.30
1951	3540	415	4,650	.115	1.30
1952	3560	382	4,850	.105	1.35
1958	3720	590	11,100	.160	3.00
1959	3750	620	11,300	.165	3.00
1960	3815	645	12,300	.170	3.20

In addition to catch basins, grit chambers at water pollution control plants are used to remove solids. Historically, grit chambers were first specified and used only where combined sewer systems were installed. With the increased mechanization of sewage treatment plants and attendant consideration of equipment protection, they now are used also in separate sanitary sewer systems. It was hypothesized that the monthly loading on a grit chamber is a function of the precipitation, since the heavier precipitation levels would be expected to wash more solids into the sewer system.

Figure 11, Seasonal Grit Removal vs Precipitation, Chicago, shows the seasonal grit removal as a function of precipitation, based on monthly data for the 1960 to 1966 period. These curves were fitted by eye for this preliminary analysis. Three preliminary conclusions can be drawn from examination of these curves:

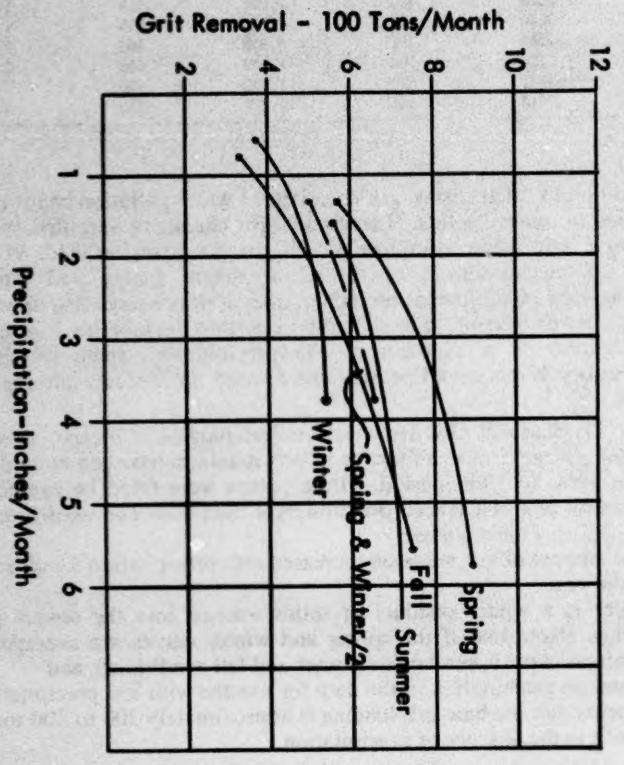
1. The amount of grit removed increases with precipitation for all seasons of the year
2. There is a winter residual of solids washed into the sewers in the spring. (Note that if the spring and winter curves are averaged, the resultant curve is similar to summer and fall conditions), and
3. Based on examination of the data for months with low precipitation, it appears that the base grit loading is approximately 200 to 300 tons per month in the absence of precipitation.

The analysis indicates that the primary source of grit in these sewage treatment plants is storm-water inflows from combined-sewer systems.

The average annual quantity of grit removed from the Metropolitan Chicago Sanitary District's three major treatment plants was 7,200 tons; that is, less than 2.5 percent of the average annual removal of other solids (313,000 tons) for the 1960 to 1966 period.(3)

A review was made to determine an economical method for determining the amount and character of solids deposited in a sewer line. Attempts at direct observations using television were unsuccessful inasmuch as the action of threading the pull cable through the line and then pulling the

FIGURE 11. Seasonal Grit Removal vs. Precipitation, Chicago



cable back with the camera was reported to disturb the material. A further complication was the fact that before a sewer line can be examined for its physical condition or notable infiltration, it must be completely clean and the flow must be below the midpoint of the pipe.

The FMC Corporation has recently completed an initial investigation of sewer flushing in connection with a research project conducted for the FWPCA. Their model studies indicate that deposited material is moved by a flushing wave. However, a study conducted at Northampton, England(4) indicated that deposited solids tended to rapidly cement themselves in shoals.

The movement of solids within the sewer appears to be a function of particle size, flow velocity, condition of pipe joints, vertical pipe alignment, and the amount of grease and detergent scum buildup in the conduit. Nevertheless, greater amounts of solids are transported by the sewage to water pollution control plants, where the heavier inorganic solids in the influent are removed in the grit chambers.

Grit chambers serve three primary functions:(5)

1. Protection of moving mechanical equipment from abrasion and other physical damage
2. Reduction of pipe clogging caused by deposition of grit particles or heavy sludge in pipes and channels, particularly at changes in direction or gradient of the conduit or at valves and gates, and
3. Reduction in frequency of digester and settling tank cleaning required as the result of excessive accumulations of grit in these units.

Combined Sewer Regulators

The major effects of urban storm water runoff pollution have been considered to be the result of combined-sewer overflows. As determined by the APWA study for FWPCA, 1967, approximately 54 million people reside in jurisdictions that are partially or totally served by combined sewers. These combined sewer systems are estimated to have 20,000 overflow points.(6)

The overflow points may be at the waste water treatment plant, at pumping stations, or at the connection between collector and interceptor sewers. At the latter overflow points, generally a facility or "regulator" is constructed to divide the flow in the collector sewer to the interceptor sewer for treatment, and to receiving waters for disposal.

The APWA study revealed that many regulators did not adequately control the flow, and that still others were not properly maintained and operated. The installation of effective sewer regulators coupled with proper operation and maintenance procedures were pointed out to be an effective and economical means for preventing or reducing pollution from combined sewer overflows.

Sources of Solids Deposits in Sewer Systems

As part of the study, a national survey was conducted to ascertain the extent and nature of solids deposition in sewer systems along with an inventory of practices in authorizing various types of sewer connections. The questionnaires were sent to 500 cities and were returned by 115. The distribution of the cities responding was as follows:

SIZE OF CITY

	Up to 10,000	10,001 - 25,000	25,001 - 100,000	100,001 - 1,000,000	Over 1,000,000	Total
East	0	18	13	9	0	40
South	0	2	8	7	0	17
Midwest	0	9	13	6	1	29
Southwest	0	0	4	8	0	12
West	0	0	10	6	1	17
TOTAL	0	29	48	36	2	115

Evaluation of the data reported on this portion of the survey have been based on consideration of these primary classifications: (1) primary sources of solids, (2) allowable sewer connections, and (3) points of solids removal.

Primary Sources of Solids

The primary sources of solids in storm sewers have been summarized in Table 24, Primary Sources of Storm Sewer Solids. The sources mentioned as having a major influence on the production of storm-water solids can be categorized in four groups: unimproved or vacant areas (streets and land), trash and street dirt, leaves and grass, and winter sanding.

Nearly 50 percent of the responding cities mentioned either or both unimproved areas and trash and street dirt as primary sources of solids that are deposited in the sewer system. The distribution of responses, especially among sections of the country, shows marked differences. The Midwest and Southwest considered unimproved areas to be a major source of solids, with 80 percent of the cities in each area mentioning it. Unimproved areas and street dirt were cited as a major source of solids in the South, where it was mentioned by 71 percent of the cities. Street dirt was designated as relatively unimportant in the Southwest where only 25 percent of the cities listed it as a problem.

TABLE 24. Summary of Primary Sources of Storm-water Solids (By City Size and Geographic Location)

	Characteristics or Sources				
	Unimproved Areas[1]	Street Dirt and Trash[2]	Leaves and Grass[3]	Winter Sanding	Other[4]
City Size					
0-10,000	-	-	-	-	-
10,001-25,000	15	15	8	12	13
25,001-100,000	22	23	23	9	15
100,001-1,000,000	22	22	13	7	27
Over 1,000,000	-	1	-	-	1
Geographic Location					
East	13	22	14	13	19
South	5	12	7	4	13
Midwest	23	12	9	9	9
Southwest	10	3	2	-	5
West	8	12	12	2	10
Total	59	61	44	28	56

[1] Unimproved areas include: unpaved and unimproved streets, alleys and parking lots; developing areas; grading soil, and wind blown dust.

[2] Street dirt and trash include: cans, bottles, sticks, garbage, various other refuse, street soiling, street washing and dirt.

[3] Leaves and grass also include trees and plant growth.

[4] Other includes: spillage, commercial, industrial and residential litter; beach sand; construction; carnival parade route litter.

Slightly over one-third (36 percent) of the respondent cities mentioned leaves and grass as a primary source of sewer solids. Again, this seemed to be relatively unimportant in the Southwest, where only 17 percent of the cities considered this a primary source.

Winter sanding was listed as a separate category rather than being combined with trash and street dirt because it was specifically mentioned by one-fourth of the cities responding to the question. As would be expected, this is mentioned by very few cities in the Southwest and Far West.

Allowable Sewer Connections

One portion of the questionnaire asked cities to designate into which type of sewer (combined, storm, or sanitary), if any, they allowed connections for the discharge of: (1) swimming pools, (2) foundation drains, (3) roof leaders, (4) sump pumps, (5) cooling water, (6) pretreated industrial process water, and (7) untreated industrial process water. The results of this inquiry are shown in Table 25, Allowable Sewer Connections. The type of sewer seems to be the determining factor in deciding which connections are allowable. Geographical location or size of city seem to have little bearing on governmental sewer connections policies.

Connections were allowed by the vast majority of cities into combined sewer systems for the discharge of all seven items. Roof leaders was the only one on which there was much difference of opinion as to whether connections should be allowed. In the Midwest and in cities with populations between 25,001 to 100,000, the majority of cities do not allow the connection of roof leaders into the combined sewer systems.

Most cities allow the connection of all the previously listed seven types of discharges except industrial process water into the storm sewer system. Slightly over half of the cities allow treated industrial process water to be discharged into the storm sewer system. In the South and Southwest, over two-thirds of the cities permit this type of connection, as do the cities with populations between 100,001 to 1,000,000. Few cities allow the connection of untreated industrial process water to storm-sewer systems. Exceptions to this policy were reported in the Southern part of the country and in cities with populations between 10,001 and 25,000. An equal number of cities reported that they did and did not allow this type of connection.

The discharge of industrial process water, either treated or untreated, into the sanitary sewer system is permitted by almost all cities. However in cities of 10,001-25,000 population, only half the cities allow the connection of untreated industrial process water into sanitary sewer systems.

About 60 percent of the cities allow swimming pool discharges to be connected into the sanitary system. Only half the cities in the West permit

TABLE 25. Allowable Sewer Connections
(By City Size and Geographic Location)

Connections are allowed for the discharge of:

	Swimming Pools		Foundation Drains		Roof Leaders		Sump Pump		Cooling Water		Treated Industrial Process Water		Untreated Industrial Process Water	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Combined Sewers														
City Size														
0-10,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10,001-25,000	8	4	9	3	8	4	10	2	8	3	6	4	5	4
25,001-100,000	9	3	10	2	5	7	11	1	9	2	8	1	7	2
100,000-1,000,000	13	2	12	3	12	3	14	1	15	0	12	1	9	3
over 1,000,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Geographic Location														
East	15	5	15	5	14	6	17	3	15	3	13	2	10	5
South	1	-	2	-	1	1	2	-	2	-	2	-	1	1
Midwest	7	4	9	2	5	6	10	1	10	1	7	2	6	2
Southwest	1	-	1	-	1	-	1	-	1	-	1	-	1	-
West	5	-	4	1	4	1	5	-	4	1	3	2	3	1
Total	29	9	31	8	25	14	35	4	32	5	26	6	21	9
Storm Sewers														
City Size														
0-10,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10,001-25,000	14	5	19	2	18	2	15	5	16	2	6	7	5	6
25,001-100,000	27	6	32	2	35	1	26	4	27	6	15	13	4	19
100,001-1,000,000	21	5	23	3	25	2	23	5	28	1	16	7	8	15
over 1,000,000	1	-	1	-	1	-	1	1	1	-	-	1	-	-

Geographic Location														
East	17	9	26	2	26	2	23	6	26	3	13	12	7	16
South	10	-	11	-	11	-	10	-	11	-	6	2	4	3
Midwest	15	4	14	3	15	2	13	3	16	3	7	6	3	8
Southwest	9	-	7	1	9	-	6	3	6	2	5	1	1	5
West	11	3	17	1	17	1	12	3	13	2	6	7	2	8
Total	62	16	75	7	78	5	64	15	72	10	37	28	17	40

Sanitary Sewers

City Size														
0-10;000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10,001-25,000	10	7	3	12	-	15	8	8	8	8	11	4	7	7
25,001-100,000	20	13	14	24	-	31	21	11	16	15	27	3	30	3
100,001-1,000,000	20	-	-	20	1	26	15	14	11	15	25	2	20	6
over 1,000,000	1	1	-	2	-	2	1	1	-	2	1	1	1	-
Geographic Location														
East	15	9	14	16	-	23	11	12	9	14	17	6	15	7
South	6	4	2	6	-	8	5	5	3	5	10	-	6	3
Midwest	15	6	6	16	-	20	14	8	8	11	14	3	19	-
Southwest	7	3	2	6	2	7	6	4	7	3	9	-	6	3
West	8	8	2	14	1	15	9	5	8	7	15	-	12	3
Total	51	30	26	58	3	73	45	34	35	40	65	9	58	16

TABLE 26. Points of Solids Removal

	Catch Basins				Have Provisions for Grit Removal		Removal of Material Required at Outfall	
	Use		Require					
Size of City	Yes	No	Yes	No	Yes	No	Yes	No
0-10,000	-	-	-	-	-	-	-	-
10,001-25,000	34	1	27	6	25	5	2	26
25,001-100,000	37	7	34	9	35	8	5	33
100,001-1,000,000	29	5	22	10	28	1	2	26
Over 1,000,000	1	-	1	-	2	-	-	1
Geographic Location								
East	37	1	31	6	32	3	-	30
South	12	4	11	4	10	2	2	10
Midwest	24	1	18	6	22	5	4	20
Southwest	7	5	4	7	10	-	1	9
West	21	2	20	2	16	4	2	17
Total	101	13	84	25	90	14	9	86

this type of connection. Sump pump connections are also allowed by about 60 percent of the cities. Slightly less than half the cities permit cooling water to be discharged into the sanitary sewer system. Only in the Southwest do a great majority of the cities allow cooling water discharge connections.

Only one-third of the cities replying permit the connection of foundation drain discharges into sanitary sewers and only three out of 76 cities allow roof leader connections to sanitary sewers.

Point of Solids Removal

The results of this analysis shown in Table 26, Points of Solids Removal, were quite consistent throughout the country. Close to 90 percent of the cities use catch basins, while only 77 percent presently require them in new construction. The Southwest is the only area of the country where the percentages using and requiring catch basins deviate greatly from these countrywide figures. Less than 60 percent of the cities in the Southwest use catch basins and slightly less than 40 percent of the cities presently require them. Eighty-five percent of the respondent cities have facilities for grit removal in their sewage treatment plants. Less than 10 percent of the cities must have dredging or other removal work carried out at sewer outfalls. Only three of the 115 respondent cities contract with private firms for catch basin cleaning.

Reference

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3. Annual Reports. Metropolitan Sanitary District of Greater Chicago, Illinois.
4. WILKINSON, R., "*The Quality of Rainfall Run-off Water from a Housing Estate.*" *Jour. Inst. Public Health Engr.* (Brit.), London. 1962.
5. *Ward Superintendent's Manual.* Dept. of Streets and Sanitation, City of Chicago. 1966.
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Sources of Urban Environmental Refuse

In May, 1967, a national survey was instituted to determine municipal data in the general area of urban-refuse generation. Included were street cleaning activities and the use of inspectors by cities to insure compliance with local ordinances covering storage, placing, and handling of refuse and yard trimmings, the sweeping of sidewalks in commercial areas, hauling and other features of street sanitation.

A questionnaire on these subjects was sent to 500 cities of various sizes in various areas of the nation, for the purpose of establishing the relationship between these municipal practices and the water pollution potentials of runoff from urban areas. The specific purpose of the survey was to identify the major litter-producing sources in various-sized communities and to determine the extent to which litter can be reduced by enforcement of regulations or other governmental and public procedures.

One hundred and forty-nine cities responded to this survey. The 149 replies were distributed in the following manner:

SIZE OF CITY

Geographical Location	Up to 10,000	10,001-25,000	25,001-100,000	100,001-1,000,000	over 1,000,000	TOTAL
East	3	15	32	11	2	63
South	2	1	5	6	-	14
Midwest	3	9	9	10	-	31
Southwest	1	-	2	10	-	13
West	1	5	11	10	1	28
Total	10	30	59	47	3	149

Each city was asked to rate, in order of their importance to the community, 21 factors that might be controlled or altered by the action of public officials and which would result in a more attractive debris-free urban community. The factors were to be ranked from one to 26 (five spaces were left for "others" to be specified). Number one (1) was to indicate the most serious; each number was to be used only once.

The questionnaire form used in this survey is included as an Appendix D to this report. The 21 items suggested for evaluation are listed as items "a" through "u".

a. Spillage from overloaded trucks

b. Litter from parades and large public events

c. Disintegration of poorly surfaced streets

d. Lack of paving at driveway and alley entrances

e. Yard refuse (leaves, lawn clippings)

f. Animal droppings

g. Deposition from windstorms

h. Improperly used trash receptacles

i. Improper storage of household refuse

j. Debris from construction and demolition

k. Roadside dumping

l. Lack of satisfactory street cleaning equipment

m. Poor refuse collection practices

n. Street trees, type or placement

o. Lack of catch basin and storm water inlet maintenance

p. Air pollution

q. Droppings from vehicles (grease, oil, etc.)

r. Poor public cooperation

s. Lack of adequate public trash receptacles

t. Lack of public education

u. Inadequate budget for street cleaning

Sources of Urban Street Refuse

The survey disclosed that six sources of street litter could be identified as problems: (1) spillage from overloaded trucks, (2) yard refuse (leaves, lawn clippings), (3) improperly used trash receptacles, (4) debris from construction and demolition, (5) roadside dumping, and (6) poor public cooperation. These six factors were listed as problems by at least 81 percent of the cities responding to the questionnaire. The tabulation of results for these six items is given in Table 27, Sources of Street Refuse—A Survey.

It appears that yard refuse was the most pressing problem of the factors listed. Sixty percent of the cities rated this factor between one and seven; 77 percent ranked it as one of the top 20 problems. This factor was classified as a major problem especially in the South where 77 percent of the cities ranked yard refuse between one and seven. As an overall problem, yard refuse affected the cities in the West more than in the other parts of the country. Eighty-six percent of the cities in the West ranked yard refuse as one of the top 20 problems. Generally, yard refuse becomes a greater problem as city size increases.

Spillage from overloaded trucks ranked second both as a serious problem and as an overall problem throughout the country. Eighty-two of the 149 cities (55%) responding to the questionnaire listed this item as one of the top seven; 76 percent ranked it between one and 20. The cities in the Midwest reported this to be their most common problem, with 74 percent of the cities ranking overloaded trucks between one and seven. Overall, spillage from overloaded trucks is more of a problem west of the Mississippi—where 86 percent of the cities ranked this item in the top 20—than in the East where only 66 percent of the cities found this source to be of sufficient importance to be ranked in the top 20. The problem generally increases in importance with increasing city size.

Ranking third as a major problem, with 48 percent of the cities rating it between one and seven, was roadside dumping. In the Southwest 62 percent of the cities ranked it in the top seven. As an overall problem, the Midwest and Southwest ranked it high, with 85 percent and 79 percent, respectively. The South did not list this source as a problem. Again, city size seems to correlate strongly with the importance of the problem. Over 90 percent of the cities with populations over 100,000 ranked roadside dumping in the top 20.

Poor public cooperation ranked fourth in importance both as a major problem (43% ranked it between 1 and 7), and as an overall problem (72% ranked it in the top 20). Fifty-four percent of the cities in the Southwest classified this as a major problem, the highest of the five area groupings of the cities. As an overall problem, the West considered it most important, with 85 percent of the cities ranking it in the top 20. This problem seems to increase with city size, with 83 percent of the cities with populations between 100,000 and 1,000,000 ranking it between one and 20.

Improperly used trash receptacles as an overall problem ranked third in importance, with 73 percent of the respondent cities rating it in the top 20. This was a major problem with 42 percent of the cities rating it between one and seven. The Midwest characterized it the most pressing of all sources, (55% rating it in the top 7 and 87% in the top 20). The West also considered it an appreciable overall problem, with 82 percent of the cities ranking it between one and 20. The problem increases with city size.

The lowest ranking of the top six factors affecting cities throughout the country was debris from construction and demolition. Forty-two percent of the cities rated this in the top seven and 71 percent ranked it in the top 20. Correlation of this factor with city size is poor. Population groupings from 10,001-25,000, 100,001-1,000,000, and over 1,000,001 showed more than 80 percent of the cities ranking this in the top 20; and in the other two population groups it ranked only 40 percent and 71 percent, respectively.

TABLE 27. Sources of Street Refuse – (by City Size and Geographic Location)

Item A — Spillage from Overload Trucks

	Rating between 1-7		Rating between 8-20		Total	
	No.	%	No.	%	No.	%
City Size						
0-10,000	3	30	2	20	5	50
10,001-25,000	14	47	5	17	19	64
25,001-100,000	33	56	12	20	45	76
100,001-1,000,000	32	68	10	21	42	89
over 1,000,000	0	0	2	67	2	67
TOTAL	82	55	31	21	113	76
Geographic Location						
East	29	46	13	21	42	67
South	6	43	3	21	9	64
Midwest	23	74	4	13	27	87
Southwest	8	62	3	23	11	85
West	16	57	8	29	24	86
TOTAL	82	55	31	21	113	76

E -- Yard Refuse

	Rating between 1-7		Rating between 8-20		Total	
	No.	%	No.	%	No.	%
City Size						
0-10,000	5	50	0	0	5	50
10,001-25,000	20	67	0	0	20	67
25,001-100,000	35	59	13	22	48	81
100,001-1,000,000	29	62	10	21	39	83
over 1,000,000	0	0	2	67	2	67
TOTAL	89	60	25	17	114	77
Geographic Location						
East	36	57	9	14	45	71
South	9	64	2	14	11	78
Midwest	18	58	6	19	24	77
Southwest	10	77	0	0	10	77
West	16	57	8	29	24	86
TOTAL	89	60	25	17	114	77

Item H -- Improperly Used Trash Receptacles

	Rating between 1-7		Rating between 8-20		Total	
	No.	%	No.	%	No.	%
City Size						
0-10,000	3	30	1	10	4	40
10,001-25,000	11	37	8	27	19	64
25,001-100,000	24	41	18	31	42	72
100,001-1,000,000	21	45	19	40	40	85
over 1,000,000	3	100	0	0	3	100
TOTAL	62	42	46	31	108	73
Geographic Location						
East	26	41	16	25	32	66
South	5	36	2	14	7	50
Midwest	17	55	10	32	27	87
Southwest	2	15	7	54	9	69
West	12	43	11	39	23	82
TOTAL	62	42	46	31	98	73

Item J -- Debris from Construction and Demolition

	Rating between 1-7		Rating between 8-20		Total	
	No.	%	No.	%	No.	%
City Size						
0-10,000	2	20	2	20	4	40
10,001-25,000	14	47	3	33	17	80
25,001-100,000	24	41	18	30	42	71
100,001-1,000,000	21	45	19	40	40	85
over 1,000,000	2	67	1	33	3	100
TOTAL	63	42	43	29	106	71
Geographic Location						
East	29	46	14	22	43	68
South	2	14	5	36	7	50
Midwest	20	65	7	23	27	88
Southwest	2	15	6	46	8	61
West	10	36	11	39	21	75
TOTAL	63	42	43	29	106	71

Item K -- Roadside Dumping

City Size						
0-10,000	1	10	1	10	2	20
10,001-25,000	13	43	7	23	20	66
25,001-100,000	27	46	12	20	39	66
100,001-1,000,000	30	64	12	26	42	90
over 1,000,000	1	33	2	67	3	100
TOTAL	72	48	34	23	106	71
Geographic Location						
East	31	49	12	19	43	68
South	6	43	1	7	7	50
Midwest	15	48	8	26	23	74
Southwest	8	62	3	23	11	85
West	12	43	10	36	22	79
TOTAL	72	48	34	23	106	71

Item R -- Poor Public Cooperation

City Size						
0-10,000	2	20	1	10	3	30
10,001-25,000	9	30	8	27	17	57
25,001-100,000	25	42	21	36	46	78
100,001-1,000,000	27	57	12	26	39	83
over 1,000,000	1	33	1	33	2	66
TOTAL	64	43	43	29	107	72
Geographic Location						
East	28	44	14	22	42	66
South	6	43	2	14	8	57
Midwest	12	39	11	35	23	74
Southwest	7	54	3	23	10	77
West	11	39	13	46	24	85
TOTAL	64	43	43	29	107	72

Summary of Findings

In summary, yard refuse was found to be the greatest problem in all parts of the country, and in fact it ranked first as a problem in all areas except the Midwest. Spillage from overloaded trucks ranked second, followed by roadside dumping, poor public cooperation, improperly used trash receptacles, and debris from construction and demolition.

These problem areas, as characterized by the public works officials, are subject to control by the enforcement of appropriate local ordinances. However, there first must be public understanding and awareness of the need for such control measures.

Section 6

Measures for Reducing the Pollution Potential of Urban Environmental Soiling

The project has identified the sources of urban environmental soiling and evaluated its pollution potential following exposure to precipitation and runoff. The contaminants are carried into storm and combined sewers via street inlets and other connections.

A distinction has been made between the inevitable and the preventable aspects of pollution from street litter and other environmental soiling. The problem is how to prevent the preventable and minimize the impact of the other sources of contact with runoff waters.

This section of the report outlines measures for reducing the water pollution potential of environment soiling. The suggested remedial practices and solutions to the reduction of water pollution include emphasis on:

1. Public cooperation—in reducing the amounts of street litter
2. Street sweeping improvements—for reducing accumulations of urban street litter
3. Catch basin design and operation improvements—for reducing discharges of supernatant liquids and entrained sludge
4. Roof drainage controls—to reduce overloading of combined sewers
5. Improved regulation and enforcement procedures—for reducing urban littering
6. Land drainage modifications—for reducing or eliminating the runoff of polluted waste waters and to minimize the import of waters containing snow and ice control chemicals
7. Reduction in indiscriminate use of chemicals—for control of unwanted pest infestations and the improvement of soil and plant nutrient conditions, and
8. Management-labor relations practices—to minimize waste collection and other municipal sanitation work stoppages.

Control of Street Litter by Public Cooperation

Community Interest

Since much of the street litter is preventable through citizen cooperation, the motivation of proper attitudes is important. Public awareness must be aroused to discourage the casual discarding of unwanted objects on sidewalks and gutters. Furthermore, it will be difficult in the absence of public interest and support to obtain an appropriate budget for street-cleaning operations.

Litter Potential

Criticism has often been leveled at American cities and the public because urban environs are not as clean as those in Europe. Studies have shown that the potential for littering is much greater here than in foreign countries. Cigarette consumption per capita, as well as newsprint consumption per capita, are far greater in the United States than abroad. Thus, the sheer abundance for discard is much greater here.

Land Use

The use of property, as well as prevailing attitudes in a district, have a marked influence on the quantities and kinds of street litter that may be produced. In outlying suburban areas, where there are one-family homes on large plots of ground, customarily, there is greater pride of ownership and little littering. In congested apartment-house neighborhoods, more litter is found due to the greater intensity of use of streets. In commercial and shopping areas, the increase in pedestrian and vehicular movement generate large amounts of street litter. In areas such as produce markets and industrial and factory neighborhoods, it is customary to find substantial amounts of street litter, reflecting heavy trucking, spillage, and other activities.

Vehicle Parking

Increases in the use of automobiles and the unavailability of off-street parking spaces result in the occupancy of the guttters by parked vehicles. In congested urban neighborhoods, it is not unusual to find virtually bumper-to-bumper parking, around the clock, seven days a week. In many such neighborhoods, the requirements of street cleaning operations have resulted in the imposition of parking regulations solely for the purpose of expediting the removal of street refuse.

Traffic

Automobile traffic contributes to street litter from the abrasion of tires on the pavement in proportion to the volume of traffic. There is also spillage from carelessly loaded trucks. Experience has shown that vehicles carrying wastepaper are particularly prone to littering when bundles are insecurely tied or when bags of scrap paper are jarred loose.

Other Factors

Other factors that play a role in the creation of the amount of street litter include the condition of pavement surfaces, street-cleaning practices, the topography and climate of the urban area, and refuse collection practices.

Basic Elements of a Street Litter Prevention Program

Planning to control street littering requires a detailed knowledge of many local factors in order to develop an effective program. Key elements that claim attention include the following.

Public Support

Experience has shown that an effective way to generate public support is through the formation of citizen groups, notably with the cooperation of local service clubs. A citizens' committee, headed by a prominent resident, can often obtain newspaper space, as well as time on radio and television programs, that would be difficult for a public official to command.

Guidance for the conduct of community programs may be obtained from "Keep America Beautiful, Inc.," 99 Park Avenue, New York, New York 10016.

Governmental Efforts

Exhortations to the public for control of littering will fall on deaf ears if there are serious defects or omissions in governmental operations. Where the community has provided inadequate funds for operational needs for street cleaning efforts, it quickly may become apparent as public interest is stimulated by an active citizens' campaign. A campaign will stimulate complaints to the street cleaning agency and may reveal its shortcomings. Thus, before a citizens' campaign fully gets underway, local government officials will find it necessary to examine closely their own operations to determine where improvement is needed. For example, if there is spillage from refuse collection operations, this will provoke comment and is a factor which must be reviewed by the appropriate officials. Another deficiency may be the inadequate number of public litter containers into which pedestrians may discard newspapers and other debris.

Legislation and Enforcement

An enforcement campaign cannot be mounted without definitive ordinances describing improper practices and prescribing penalties for their violation. Existing legislation should include the requirements for household refuse receptacles and place specific responsibility for the cleanliness of sidewalks, the curbing of dogs, the control of scavengers, the control of the distribution of handbills and advertising matter, etc. Keep America Beautiful Project Guide Number 3, Litter Laws, Appendix A of APWA's Street Cleaning Practice, 2nd edition, page 297, and Appendix F of this section, may be used as check lists for the adequacy of local ordinances.

Public Education

A comprehensive program to inform the public of its responsibilities needs to be undertaken by the governmental agency responsible for clean streets.

The basic elements of a program may include all or part of the following:

1. Digest of Ordinances—The legal requirements for handling household refuse, the curbing of dogs, the proper use of public litter receptacles, etc., should be available in leaflet form. In some communities these requirements are printed on heavy cardboard and given to new residents. If there are foreign-language-speaking groups in the community, it may be worthwhile to translate these requirements into the appropriate language, so that all citizens may understand what is expected of them
2. School Program—A "Clean Community" message may be developed into a standardized format, illustrated with appropriate slides or movies, which can be presented to school children. This is considered an excellent means for instilling cooperation
3. Civic and Other Groups—If a public-education unit is active, it will, no doubt, receive requests from local civic organizations and other groups for a representative to speak on keeping the community clean.

These speaking opportunities provide a means of disseminating information

4. Press, Radio, and Television—An aggressive public-education office will utilize occurances related to the delivery of new sanitation equipment, or the commencement of a new program, etc., as a means to obtain space in the various communication media which can carry the clean community message to a wide audience
5. "Cleanup Weeks"—A common practice in the spring is to organize a "cleanup week," during which the public is motivated to clean their premises and dispose of accumulated trash. These cleanup weeks provide an opportunity for a concentrated educational program stressing the public's responsibilities for keeping the community clean
6. Litter Containers—There is a wide variety of litter containers which may be deployed on the streets for pedestrians' convenience. Containers may vary from a small, open basket type, which fits on parking meter posts, to large, 55-gallon containers painted in suitable fashion. (See Keep America Beautiful, Project Guide No. 2, Litter Receptacles, for a non-technical discussion and description of various types), and
7. Campaigns—Experience has shown that a multipronged attack on litter must rely upon a variety of techniques for a successful effort. Extensive campaigns have been conducted in several major cities, where an active citizens' committee and the local government have combined to attack the problem of street refuse with a coordinated program.

As an example, one major city's program was designed to obtain cleaner streets by enlisting the public's assistance and by more effective use of its own personnel. The program relied on the following:

- **An Estimate of the Problem**—Surveys and studies were made to prepare a comprehensive action plan. Detailed field inspections were done in those neighborhoods known to contain large amounts of street dirt and litter. Maps were prepared, indicating the location of the areas specifically targeted for cleanup, including chronically littered streets, vacant lots, and backyards
- **Operational Planning**—After the basic data and related information was collected, planning begins on how the excess refuse was to be collected, the local organizations to be contacted for cooperation, etc.
- **Interdepartmental Participation**—A Mayor's Interdepartmental Committee for a Clean City brought together all local governmental agencies concerned with making inspections and enforcing the laws that have a bearing on street dirt. For example, the Police Department was involved in moving-vehicle violations, preventing the dumping of refuse illegally on the streets by truckers or others, and regulating the storage of construction materials on the sidewalks and streets. The Fire Department was concerned with the storage of refuse within a building, in a manner that might create a fire hazard. The Health Department was concerned with the handling and storage of refuse by

food-handling establishments. Other city departments extended related cooperation

- **Organized Citizens' Participation**—A mayor-appointed Citizens' Committee for a Clean City was active and was able to obtain free advertising space in the newspapers and time on radio and television
- **Community Relations**—Through governmental agencies efforts, and attempt was made to seek public cooperation directly. This was done by making speeches, distributing leaflets to the press, radio and television, and promoting knowledge of the Department's activities and services. There was an extensive program directed to school children. A talk, usually given in the school auditorium, supplemented by a documentary film and other visual aids, was used and has been well received
- **Enforcement**—When appeals to civic pride do not produce the necessary cooperation, punitive measures must be used. Generally, the flagrant violators are a small minority with whom the public has little sympathy. Summonses were issued for the littering of streets and sidewalks; dumping or throwing garbage or waste into the streets or vacant lots; neglecting to sweep sidewalks or sweeping rubbish into the streets; dropping waste from vehicles; placing over-filled or uncovered garbage cans, and loose or untied newspapers outside for collection; etc. Personnel in other city departments were assigned to serve summonses for related violations
- **Litter Baskets and Anti-Littering Signs**—The city purchased, and placed on the streets, more litter baskets. It also posted anti-littering warning signs advertising the penalties for littering. Citizens often excuse their untidy habits by complaining that they do not have a place to throw litter and are, therefore, compelled to throw these items on the streets and sidewalks. Thousands of warning signs, of striking design, were placed on public lighting poles throughout the city
- **Littered Lots**—The location of littered lots was determined. An attempt was made to have the property owners clean their lots. Where this was not done, the city cleaned the lots and billed the property owner for the cost. As part of this program, a special bulky refuse service was instituted which offered free pickup of unwanted large household objects, such as mattresses, sofas, etc. This proved to be very popular and was continued on a year-round basis, and
- **Operation "Big Sweep"**—Early in the spring the action program was planned. Generally it consisted of two phases: an educational phase, in which the public was notified of the various methods that were going to be taken and requesting their cooperation; and an enforcement phase, which commenced after a preliminary warning period, in which summonses were issued to all violators.

Current Street Refuse Control Practices

In addition to the street refuse control practices previously described, some special problems are commonly encountered in keeping streets clean.

Abandoned Automobiles

Abandoned automobiles become a target for children and vandals to break glass, to strip valuable components, etc. The result is an area of litter around an abandoned vehicle. To cope with this problem the local government either arranges for automobile removal with its own forces, or hires a local contractor to do so. The auction or public sale of abandoned vehicles may generate sufficient revenue to defray all, or part, of the towing and disposal costs. (See: Automobile Disposal—A National Problem, U.S. Dept of the Interior, Bureau of Mines, 1967.)

Leaves

In streets shaded by deciduous trees there will be a few weeks in the fall when large quantities of leaves have to removed. Leaves are difficult to handle because of their bulk and, when dried, may be easily blown by the wind. Leaves may clog catch basins. Recent studies have shown that leaves may contribute to water pollution. (See K. V. Slack and H. R. Feltz, Tree Leaf Control of Low Flow Water Quality in a Small Virginia Stream, Environmental Science and Technology, 2:2:126 Feb. 1968.) A variety of material handling equipment, including suction devices are used to pick up leaves.

Construction Sites

Demolition and construction of buildings will generate street debris because of the heavy trucking and carting of materials. At times, bulk construction materials, such as sand, gravel, brick, etc., may be stored on the streets and sidewalks. The storage of such loose bulk materials may generate large quantities of debris unless carefully controlled. Inspection and enforcement actions are required to deal with this source of street debris. The issuance of permits for demolition and construction of structures may facilitate community control of nuisances arising from these activities.

Sidewalks

Litter moves readily from the sidewalk to the street. Local legislation should specify who is responsible for cleaning the sidewalks and a continuing enforcement campaign may be necessary to insure that those responsible meet their obligations. Otherwise much of the litter that originates on the sidewalk, will find its way into the streets.

Vacant Lots

Owners are generally responsible for the maintenance of vacant lots in a nuisance-free condition. Rainstorms may wash out debris from lots onto the public streets. To prevent littering of lots, fencing may be required. The apprehension of vacant lot litterers may be difficult. The problem may be passed on to the property owners if legal proceedings are taken.

Dead Animals

Small dead animals, such as cats and dogs, are often found on streets. Such animals should be picked up promptly and disposed of to prevent a nuisance.

Spring Cleaning

Communities in the snow belt that use abrasives for improving traction on ice and packed snow, must deal with the accumulation of sand and cinders that remain on the streets. The prompt removal of this debris is necessary to avoid clogging of the catch basins and sewers. If possible, it should be removed periodically between winter thaws. During spring cleanup drives, additional refuse collection service for bulky household objects may be offered by the community's refuse collection agency. Other communities may offer this service on a year-round basis.

Improved Street Cleaning Practices

Every pound of street litter that is removed from curb areas before precipitation and runoff come in contact with it means a reduction in the contaminants that are washed off and transported to street inlets and to storm and combined sewers. Means for reducing the waste volume at the water interface are obvious: more effective and more frequent cleaning.

The dust and dirt fraction of street litter is the most difficult to remove effectively, and the impact of runoff pollution increases mathematically by the number of days the street litter has accumulated prior to a runoff incident. As stated, reduction of this progressive pollution potential may be accomplished by more effective pickup of the dust and dirt fraction and by modifying the frequency of cleaning.

The value of vacuum sweeping in the pickup of the sand material in the sweeper evaluation tests which were made was demonstrated. Here again it is important that the local governmental jurisdiction carefully evaluate its local problem. For instance, in 1961, the City of Winnepeg, Canada found while evaluating a foreign-made vacuum sweeper that the presence of clay particles in their street litter effectively clogged the air hoses employed in the sweeper because of the amount of water needed to control dust. American made vacuum-type machines, which do not use a water spray, have had difficulty with clay size particles blocking the air filters.

Presently vacuum-type sweepers must operate on level pavement in order for the vacuum to be effective. Their efficiency could be expected to be low on deteriorated streets or on those with uneven pavement.

Pure-vacuum sweepers appear unable to dislodge accumulated litter which adheres to the surface. Therefore, the available machine uses a broom to dislodge the material and a vacuum to carry the litter into the machine.

Additional development of vacuum-type machines will be necessary before they can be generally used.

Increased frequency of operations increases the number of curb miles that one machine can cover per day. Where large amounts of street litter are allowed to accumulate and cleaning intervals range from 14 to 30 days, more than one pass of the sweeper is necessary. Inasmuch as heavy accumulations of litter reduce the efficiency of vacuum sweeping, it appears desirable to use a vacuum sweeper in tandem with mechanical pickup sweepers to accomplish a "clean sweep." However, the most likely approach is the improvement of existing equipment and the establishment of standards for a "clean" street.

The establishment of standards for a clean street has been elusive. Streets have been cleaned for years but no one has established criteria for judging when a street is clean. As much as five to ten pounds of dust and dirt along 100 feet of curb, in the absence of other types of street refuse, does not appear particularly dirty. The field tests made for this study indicated that as much as five pounds of dust and dirt per 100 feet may be left after street cleaning operations. In actual practice, in many neighborhoods, the amount of paper tolerated by the public will govern sweeping frequency.

It would appear that a standard for well built-up areas of the order of one day's contribution of dust and dirt, say 1.5 lb/100 ft should be the maximum remaining after street cleaning. The maximum accumulation prior to cleaning could be on the order of a weeks' accumulation, say 10.5 pounds plus the 1.5 pounds residual or 12 pounds.

Where adjacent driveways and parking lots are unpaved, or the area between the curb and sidewalk is not properly maintained, these suggested standards will be almost impossible to achieve, as indicated by the field tests made.

Catch Basins—Elimination or Improvement of Design and Operation

The role of catch basins as intercepting devices in storm and combined sewer system street inlet structures has been explored in Section 5 of this report. The studies have clarified the problems induced by the retention of liquids and sludge solids in these catchment chambers and the subsequent disturbance and displacement of these materials during periods of runoff.

The pollution potential of catch basins and their contents are dependent, in some measure, on the time period between the runoff incident and the antecedent precipitation and runoff. The longer the period, the greater the septicity encountered and the more severe the pollutional first-flush effect with the release of the old retained liquid and the partially decomposed organic matter in the basin solids.

Even with the obvious drawbacks of catch basins, there is some value in intercepting solids from the runoff waters entering separate and combined sewers. The solids might otherwise shoal in sections of underground sewers and at sewer appurtenance structures which are less accessible for cleaning than are basins. Furthermore, the value of basins for trapping inlet connections from the street into combined sewers and preventing the emission of sewer odors can be important.

Based on the analysis presented in this report, it is concluded that catch basins under certain circumstances may be an unnecessary component in combined or storm sewer systems as far as their primary purpose of preventing sewer clogging is concerned. This obsolescence of their former function is due to two factors (1) greatly reduced quantities of solids entering the sewer system, via the street inlets, and (2) technological advances in sewer design and cleaning as well as street cleaning.

During the early years of sewer systems, catch basins were important due to unpaved streets, the use of flat grades, inefficient means of sewer cleaning, lack of routine street cleaning, and low flows in the sewer system. Subsequent paving of streets and designed sewers that provided adequate self-cleaning velocities ensued after the turn of the century. Mechanized methods of sewer cleaning now permit cleaning of sewer lengths approximately 1,000 feet at a time.

In addition, mechanical street sweepers now remove substantial quantities of solids from the streets even though dust and dirt residues do remain after sweeping. The impact of street sweeping on catch-basin loadings has been shown in this report. Despite the fact that catch basins in Chicago were cleaned twice as often from 1959 to 1960 as compared with the 1947-1952 period, the quantity of solids removed increased by only about 30 percent. This reduction is attributed to the introduction of routine street sweeping in 1955. Water use and subsequent sewage flow also has increased tremendously relative to the flows that prevailed 50 to 100 years ago. Increased water use provides a desirable flushing effect on the sewer system.

In lieu of elimination of basins (and it must be pointed out that widespread use of basins was reported in the national survey described in this report), basic design of such structures could be improved to minimize the volume of liquid retained and to induce greater stilling effects. The design of catch basins merits the attention of technical organizations, regulatory agencies and design engineers.

Maintenance practices command attention. Greater frequency of cleaning would minimize the amounts of sludge retained and subject to flush-out during storms. It is obvious that a full basin ceases to perform its function as a retention device. It is noted that some cleaning operations do not remove all of the deposited solids allowing resuspension of deposited solids by incoming flow.

Control of Roof Runoff Drainage

In urban areas, roofs of structures represent a large part of the impervious surfaces which increase runoff. In many combined-sewer communities, the drainage from such roof areas is discharged into public sewers, via the single property sewers used in such cases. The APWA study of Problems of Combined Sewer Facilities and Overflows 1967 emphasized the great cost of separating such house lines to make complete separation of storm and sanitary sewers a reality.

The emphasis placed on urban waste pollution potential in this study raises the question of whether the elimination of roof drainage from storm and combined sewer systems would be a feasible and practical means of reducing this pollution hazard. It would appear that the three major solids sources on roofs would be air pollution dustfall, tree leaves, and bird or squirrel droppings.

The estimated annual quantity of dustfall onto the roofs in the 10 acre (4 ha) residential area discussed in Section 4 was 0.42 tons per year. For structures with flat roofs, the majority of this dustfall would be expected to be washed into the sewer system. The quantity of dustfall remaining on gabled roofs would be minimal due to the direct exposure to the wind. The total annual quantity of suspended solids discharged as overflows is about 1.5 tons from the 10 acre (4 ha) residential area so that the dustfall from roofs is a factor meriting more detailed study.

If the sole objective is control of storm-water pollution, then it would be desirable to disconnect roof leaders and discharge the runoff onto pervious areas. This remedial measure would virtually eliminate this solids source for the more important lighter storms in the unit area under study. Approximately 40 percent of the study area overflows might be eliminated if all roof leaders were disconnected.

An additional benefit from disconnecting roof leaders would be a reduction in the size of the drainage facility needed. Indeed this alternative is frequently considered in sewer planning studies. Sewer systems are usually designed to provide adequate service for a rare event occurring under future conditions. The "trade-off" may be analyzed in the incremental savings in the sewer system by eliminating roof drainage versus the inconvenience that is incurred by residents occasioned by the discharge of roof drainage to the surface. Storm water pollution control adds a new dimension to this analysis. Other things being equal, surface discharge of roof drainage permits an urban area to take advantage of the ground's natural purifying action whereas otherwise it may be necessary to provide treatment of this storm water. Thus, water quality considerations provide a "plus" factor in favor of surface discharge of roof discharge.

It does not appear possible to develop a *prima facie* argument for or against surface discharge of roof drainage. Surface drainage is only of use in those portions of the urban area that now have or are expected to have the requisite topographic-geographical features. An alternate method for use on combined sewer systems where pervious areas are not available could involve a system of temporary on-site storage of roof runoff with gradual release of the flow after the storm.

Regulations and Enforcement Procedures

Adequate legal authority must be available to local public officials who have the responsibility of maintaining clean streets and reducing pollution of storm-water runoff. As previously mentioned, both Keep America Beautiful, Inc., and the APWA in its book "Street Cleaning Practices" have published typical and model anti-litter ordinances. As a part of this study, 224 U.S. cities of varying sizes and geographical locations were asked to supply copies of ordinances in specific categories related to control of pollutants capable of entering storm or combined sewers to supplement the existing published information. Replies received from well over half the cities, supplemented by "model" ordinances, were analyzed within the following eighteen classifications:

a. Anti-litter
b. Debris, etc., on vacant lots
c. Erosion control
d. Parking lots and garage
e. Handbills
f. Site cleanup of circuses, carnivals
g. Produce markets
Weed control
h. Discharges into sewers
i. Cleanliness of Private Property
j. Street excavations
k. Vehicular spillage and littering
l. Moving and demolition of bldgs
m. Bonfires and incineration
n. Bldg construction materials
o. Animals and animal care establishments
p. Storage and disposition of
q. garbage and rubbish
r. Authorized and unauthorized dumping

The results are presented in Appendix F.

Ordinance Enactment and Enforcement

As a part of the nationwide survey to determine the types of street refuse problems encountered by local public works officials, respondees were asked to indicate for which sources of street litter the local jurisdiction has enacted and is enforcing control ordinances.

Only five sources of street litter were reported to be controlled by city ordinances in the majority of the responding cities. A sixth source was controlled by ordinance in nearly 50 percent of the cities. Ordinances affecting 15 items also listed were found in less than 25 percent of the cities. Table 28, Ordinance Control of Sources of Street Litter, summarizes the responses for the six categories most frequently controlled by ordinance.

It should be noted that five of the items found in Table 28—spillage from overloaded trucks, yard refuse, debris from construction and demolition, roadside dumping and improperly used trash receptacles—were also among the six factors found to be nationwide problems. Although from 53 percent to 77 percent of the cities have existing ordinances to control problems caused by each of the items, and from 52 percent to 82 percent of these cities reportedly enforce their existing ordinances, satisfactory solutions have not been found for these problems. The sixth item, improper storage of household refuse, has evidently become less of a concern to cities through the existence of ordinances that impose restrictions upon methods of refuse storage.

TABLE 28. Ordinance Control of Sources of Street Litter

(Data From 120 Cities)

Item	Number of Cities With Existing Ordinance	Cities Enforcing Existing Ordinance
Spillage from overloaded trucks	114	82
Yard refuse	90	47
Debris from construction and demolition	86	61
Roadside dumping	84	69
Improperly used trash receptacle	79	48
Improper storage of household refuse	68	44

Regulation of Drainage

Precipitation and runoff are the inevitable factors with which urban areas must cope. The fact that runoff rates are increased by the imperviousness of these community areas is given careful consideration by designers of storm and combined sewer systems because these rates affect conduit sizes, gradients, and locations of these public utilities.

Emphasis on reducing the pollutional effect of runoff waters adds a new dimension to the drainage of urban areas. If the amount and rate of runoff can be reduced and thereby reduce the contact of these waters with street litter, the pollution potential could be minimized. This points up the possibility of providing structures that will impede storm-water runoff in suitable locations. This may be feasible even in certain congested urban areas.

The interception of storm-water runoff for use in recreational areas, or for leaching into, and supplementing ground water resources, is becoming a common practice. For example, Suffolk County and Nassau County, on Long Island, New York, intercept runoff water in seepage basins located in numerous points along roadways, in order to supplement the ground waters from which both counties derive all their water supplies, both public and private.

Catchment areas designed for use on storm sewer systems in order to minimize the cost of sewer construction have also been constructed. For example, in regions where precipitation is not prolonged, parks and recreational facilities have been built, designed to be flooded to a depth of several feet during storms. Small diameter pipes discharge the runoff over a long period of time.

During the project study, the preliminary plans for the Town of Dollard Des Ormeaus, Montreal, Canada were reviewed.(1) These plans call for the storm runoff from the entire urban area of 2,320 acres (940 ha) to be concentrated in a permanent lake of 27.5 acres (11.1 ha) having a capacity of 203 acre-feet of water as a feature of a Town Park. Similar projects have been constructed in Minneapolis, Minnesota and St. Boniface, Manitoba. The latter project has been stocked with game fish.

Such facilities should enhance the quality of the receiving waters, reduce pollution shock loads, minimize storm water collection costs, and perhaps provide a needed recreational facility. These benefits will be negated if pollution control is not systematically practiced to reduce pollution of storm water runoff.

The design of drainage facilities where the runoff is primarily from streets that are salted for the control of snow and ice is extremely important. Runoff must be discharged to an area where there will be adequate dilution to prevent salt concentration. If street drainage is the major source of water for a small lake or impoundment, such as in a park, increasing salinity may cause fish kills or impair the intended uses of the latter discharges. Unfortunately, it is difficult to predict the extent that salt will be used in a particular community. Some jurisdictions already salt local residential streets, and the total use of salt by all jurisdictions appears to be increasing.

Minimizing Effects of Litter and of Yard and Garden Debris

Reference has been made of the importance of litter containers and public education in reducing the amounts of street litter and the eventual contact of such debris with runoff water. Such control containers are of minimal value if they are not available in adequate numbers, at proper locations, and kept emptied by scheduled collections.

Collection schedules must be adjusted to actual experience and times of their use by pedestrians. For example, litter containers are often the recipients of garbage and rubbish from nearby dwellings and even business establishments. This points up to the need for adequate regulations covering the use of public litter receptacles and the enforcement of such rules.

Over and above the pollution control value of these refuse containers, they augment community cleanliness and beauty. The use of such receptacles is as an inducement for street tidiness that can lead to even more important litter control efforts on the part of the public.

Yard and garden litter also must be given special consideration if accumulations of leaves and grass are not to add to the pollution potential from the urban environment. It is a paradox that the greater the cleanliness and beauty of properties, the greater are the amounts of such on-site wastes produced—much of it of vegetative origin—and the more frequent are the required collections of this material.

Over and above the seasonal increase in such refuse during spring cleanup periods, there is need for regular all-season handling practices on the part of public forces. Workable rules must be invoked and enforced covering the manner in which yard and garden debris is handled on-property, how it is stored at the street line, and how and when it will be collected and removed from the urban environment.

Inasmuch as yard and garden refuse was reported by public works officials as a major source of street refuse in most communities, it would seem appropriate that greater efforts be made to accommodate the public in removing such refuse. In many instances the public has shown its willingness to participate in the removal of such material, particularly when large amounts are involved. Such practices as having convenient weekend hours at disposal sites or stationing adequate refuse facilities at strategic locations allow the public to help remove such refuse. As an example, in some western cities "garbage train" containers are placed about the city and emptied by the "mother" truck as required. The locations are varied each weekend on a regular schedule to further aid the public.

Minimizing Effects of Chemicals

The potency of various compounds to control environmental vectors of human discomfort, inconvenience, and safety hazards has led to their increased use as pesticides, insecticides, fungicides, herbicides, rodenticides, and soil conditioners and sources of plant nutrients.

Such municipal operations as tree spraying, weed control along streets and on open areas; rat control, control of starlings, pigeons, gulls and other birds; and the fertilization of park and parkway areas, add to the presence of chemical residues in the urban environment. Similary, use of such materials by property owners adds to the chemical burden of street refuse and the pollution potential resulting from rainfall and runoff contacts.

Any program to minimize pollution stemming from such sources will require a choice of materials which will have the least residual effect and the closest possible control of the amounts used. It can be said, almost as an axiom, that such materials are used in greater amounts than necessary by most people.

Snow and Ice Control

Field tests indicated that high salt concentrations occurred in storm water runoff. It would be preferable to use a non-polluting material in place of salt. However, the other chemicals that have been used have perhaps even greater adverse after effects than salt. It appears that in small watersheds draining highways and streets, the drainage designer must consider the possible accumulation of salt that will occur and seek to use salt-resistant grasses and vegetation, as well as endeavor to bring about dilution of street runoff with flow from non-salted areas.

Additionally, in the case of larger watersheds, where controls are placed on industries to limit the discharge of salt brine to optimize river conditions, the political jurisdictions using salt must be accounted for in determining the "salt balance" for the system. During low flow periods before the spring thaw, it may be necessary to limit industrial discharges into some receiving waters or sewers to accommodate the discharge of the salt used on streets and highways.

Pesticides, Herbicides, and Fertilizers

The use of chemical formulations for controlling insect and plant growth is increasing. Local public works officials must be alert to the pollution potential of these materials and govern their use of the chemicals in a manner that will minimize pollution.

Table 29, Comparative Toxicity of Several Organic Phosphorus and Chlorinated Hydrocarbon Insecticides to Bluegills in Soft Water at 25°C, lists 18 commonly used formulations and their relative toxicity. In addition to toxicity, some pesticides impart highly objectionable tastes and odors to water.

TABLE 29. Comparative Toxicity of Several Organic Phosphorus and Chlorinated Hydrocarbon Insecticides to Bluegills in Soft Water at 25°C. (1)

Organic Phosphorus Insecticides	96-hour TLm mg/L	Chlorinated Hydrocarbon Insecticides	96-hour TLm mg/L
Guthion	0.0052	Endrin	0.0006
Delnav	0.0340	Toxaphene	0.0035
Di-Syston	0.0630	Dieldrin	0.0079
Malathion	0.0900	Aldrin	0.0130
Parathion	0.0950	DDT	0.0160
EPN	0.1000	Heptachlor	0.0190
Chlorthion	0.7000	Chlordane	0.0220
Methyl Parathion	1.9000	Methoxychlor	0.0620
Dipterex	3.8000	BHC	0.7900

(1) Values from Pickering, Q.H., C. Henderson and A. E. Lemke. "The Toxicity of Organic Phosphorus Insecticides to Different Species of Warmwater Fishes." Trans. Amer. Fish. Society. 91. 175-184. April 1962.

To be effective as a pesticide, a chemical compound must be stable and long lasting—and it is this characteristic that makes it a continuing threat after it is used. Most formulations do not degrade fast enough to remove undesirable properties and thus continue to be concentrated in the food chain, as higher forms feed upon affected lower forms of life.

Although most common formulations are stable, there are some that are less stable. For instance, phosphorus-based compounds degrade faster than chlorinated hydrocarbons.

Degradation of most chlorinated hydrocarbons is more rapid under anaerobic as opposed to aerobic conditions except for heptachlor epoxide and dieldrin.(3) Thus, degradation could be expected to take place in bottom-mud deposits when water temperatures are at least 20°C.

The local jurisdiction plays only a small role in the total use of all of these chemicals. Agriculture is by far the largest user. Individual home owners constitute a substantial user within the municipality. However, the local public works officials does have the responsibility of ensuring that the choice of the least toxic and most degradable formulation is used, and that all formulations are applied in a manner that will minimize storm-water pollution.

Better Labor-Management Relations

A new factor in America's urban-industrial growth is influencing governmental sanitation practices and costs—the necessity to cope with demands for better working conditions and wages by governmental employees. The 10-day strike in 1968 that literally buried New York City under more than 100,000 tons of uncollected garbage and rubbish became a matter of national interest, while it created conditions variously described as "a health emergency," "a community disgrace," and "a political football."

Work stoppages have involved cities all over the country. The calamitous refuse collectors' strike in Memphis, Tennessee, embroiled the city in a dispute which had repercussions with national and racial overtones. These events and their social-economic-political impacts are yet fully to be assessed. To guard against the cessation of essential munnicipal services upon which the health, safety, and economic welfare of urban residents depend, laws have been invoked prohibiting strikes by public employees. But these laws and the punitive actions invoked against strikers in the public service have failed to prevent labor unrest and have given ample warning of the threat of uncollected garbage and refuse, uncleaned streets, and other insanitary conditions. Something must be done to prevent the proliferation of such situations or to minimize their effects.

The sporadic incidents referred to have emphasised the dependence of the modern urban environment on systematic and uninterrupted sanitation services. In addition, they have made the public more appreciative of the problems faced by city workers, administrators, and officials. If it likewise has alerted municipal management personnel to the hazards involved and forewarned them of the need for prevention of such conditions by modern labor-management practices, the unauthorized and "illegal" strikes of recent months will have served a valuable service.

Conditions increase the amount of litter accumulations and provide greater contact with precipitation and runoff. The action taken by the New

York City Board of Health in declaring a health emergency during the 1968 waste collectors' strike offers dramatic proof of the greatly increased pollution potential which can result from work stoppages of this nature. The challenge is self-evident: strikes against government are intolerable, but they are not inevitable. Efforts must be made to prevent the breakdown of labor-management relations which can maintain the equilibrium of such essential services as street sanitation and other facets of environmental cleanliness.

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1. "Storm Water Drainage System Incorporating a Lake." Lindsay, Cosgrove, and Associates. 1966.
2. HILL, DAVID W., and MCCARTY, PERRY L. "Anaerobic Degradation of Selected Chlorinated Hydrocarbon Pesticides." *Journal Water Pollution Control Federation* 39. 8. August, 1967.

Section 7

Cost of Prevention and Treatment

The information contained in preceeding sections of this study has described various activities that a local agency can initiate to reduce the pollution of urban storm-water runoff. These activities may be summarized as:

1. Establishment of public education and cooperation programs
2. Enactment and enforcement of appropriate ordinances
3. Increased street cleaning operations
4. Improved design and operation of drainage control systems, and
5. Awareness of the pollution potential of street refuse and other pollutants which may come into contact with storm water, and effective actions to be taken each time such identification is made.

Interdependencies and Economic Aspects of Solids Control Facilities.

Various litter-control program components have been described. A preliminary evaluation of the tradeoffs that may exist among these facilities for the unit area described in Section 4 will be made for comparative purposes. The unit labor costs of catch-basin cleaning, sewer cleaning, and street sweeping are shown in Table 30, Historical Unit Cost of Catch Basin Cleaning, Sewer Cleaning and Mechanical Street Sweeping, Chicago, for ten years of record.

The estimated cost of mechanical sweeping as shown in Table 30 is $100 per eight-hour shift. The $100 is broken down into $70 for the sweeper and $30 for the operator. This figure will be used for comparative purposes.

Based on the above estimates, the cost of removing debris from the unit area have been tabulated in Table 31, Comparative Unit Costs of Solids Control Within a 10-Acre (4 ha) Area of Origin

The much higher catch basin cleaning costs as compared with the cost of street sweeping per ton removed suggests that more intensified street sweeping could serve as an alternate for catch-basin cleaning.

Street Cleaning

In order to minimize pollution, the frequency of street cleaning operations should be set by the relative production of street litter-of individual areas and the relative frequency of precipitation events at various times of the year considered. Scheduling of street cleaning activities could become very

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TABLE 30 Historical Unit Costs of Catch Basin Cleaning, Sewer Cleaning and Mechanical Street Sweeping, Chicago

Year	Catch-Basin Cleaning ($/Catch Basin*)			Sewer Cleaning ($/1000 lin. foot*)		Mechanical Street Sweeping ($/Shift**)
	Hand	Eductor	Orange Peel	Flushing	Scraping	
1946	$1.66	$1.75	-	$4.27	$65.80	-
1947	1.57	-	-	4.07	69.40	-
1948	1.81	2.49	-	5.08	93.50	-
1949	1.91	2.04	-	4.81	100.60	-
1950	2.20	2.18	-	4.79	101.70	-
1951	2.22	2.56	-	4.05	121.40	-
1952	2.30	2.65	-	5.60	150.90	-
1958	3.33	3.82	$4.36	8.92	189.40	-
1959	3.25	3.74	4.14	8.84	198.40	-
1960	3.29	3.47	4.38	8.12	187.00	$100 Est.

* Labor cost only. Labor is about 90 percent of total cost for catch-basin cleaning. Proportion of total costs for sewer cleaning are unknown. Source — Annual Reports, Bureau of Services, City of Chicago.

** Labor ($30) + sweeper ($70).

TABLE 31 Comparative Unit Costs of Solids Control Within a 10-acre (4 ha) Area of Origin

Control	Cu. Yd/yr	Tons/yr	$/Ton	$/year
Catch Basin[a]	17.4	5.2	34.00	177
Mechanical Sweepers[b]	19.7	10.1	13.30	134
Sewer Scraping[c]	1.0	.3	137.00	41
Sewer Flushing[c]	-	-	-	32
Garbage: 1/2-Grinding[d]	-	13.8	178.00	1080
1/2 as Refuse[e]	-	13.8	13.80	190

a) Source: Tables 18 and 30 For 1960 Conditions

b) Source: Tables 30 and unpublished data for City of Chicago

c) Source: Tables 23 and 30

d) Source: Table 5 and estimated annual cost of home garbage grinders equal $15 -- 72 dwelling units in unit area

e) Source: Table 5 and unpublished 1965 unit refuse collection cost for City of Chicago complex and might require the use of a computer program to permit flexibility in scheduling the necessary operations.

A cost-benefit analysis is also needed to determine the best combination of street-cleaning equipment for the desired frequency and degree of cleaning. For instance, in Chicago, to accomplish maximum removal of dust and dirt, the second pass might well be made by a vacuum sweeper working in tandem with a mechanical pickup sweeper. If a second mechanical sweeper were used in tandem, the second sweeper could use a wider broom pattern to increase sweeping efficiency. The number of factors which must be considered in a cost analysis are complex, but a simplified hypothetical analysis follows. It will be assumed that a specific area is being evaluated to determine the optimum sweeping frequency and equipment.

Cost per shift including operation, maintenance and labor			$100
Cost to post streets, per 5 curb miles			$ 40
Curb Miles Cleaned per Shift			
Mechanical	@ 30 day frequency	10	
	@ 14 day frequency	15	
	@ 7 day frequency	20	
	For second pass	20	
Vacuum	For second pass	20	

Percent Cleaning Efficiency Considering only Dust and Dirt

	Cleaning Frequency	First Pass	Second Pass	Third Pass
Mechanical	30	60	70	80
	14	70	75	80
	7	75	80	80
Vacuum			95	

Table 32, Relative Cost of Street Cleaning, uses the listed factors and characteristics to compare the cost of using mechanical sweepers alone at 30, 14, and seven-day frequencies and then in conjunction with a vacuum sweeper. As expected the lowest remaining amount of dust and dirt is associated with higher monthly costs. The use of a vacuum sweeper for the second pass lowers the total cost per curb mile and reduces the amount of street dust and dirt left on the street. For a total cost evaluation, the cost of removing the solids from the catch basins and sewers that were not removed by street cleaning needs to be determined on the basis of frequency of precipitation.

The example used, at the values assumed, indicates that sweeping weekly would cost approximately the same amount of money as at 14-day intervals, with a 50-percent reduction in the average amount of material

TABLE 32. Relative Costs of Street Cleaning

Case	Days between Sweepings	Number of: Mech-anical Sweepers	Vacuum Sweepers	Posting Crews	Passes by Sweepers	Per Shift: Curb Miles Cleaned	Cost/ Curb Mile	Dust & Dirt * lb/100 ft of Curb: After Sweeping	Collected 28 days	Average on Street	Cost/ Curb Mile/ 28 days
1	28	2	-	2	3	10	$28.00	1.0	41.0	21.5	$28.00
2	14	3.3	-	4	3	20	24.65	0.3	41.4	10.7	49.30
3	7	1	-	xx	2	10	10.00	0.6	39.6	5.5	40.00
4	28	1	.5	2	2	10	23.00	0.9	41.1	21.5	23.00
5	14	1	.75	3	2	15	19.66	0.3	41.4	10.7	39.32
6	7	1	1	xx	2	20	10.00	0.13	41.4	5.3	40.00

* assume dust and dirt accumulates at 1.5 lb/day/100 ft of curb or 42 lb/28 days/100 ft of curb

xx assume use of permanent no parking sign for sweeping period, which is feasible with a weekly parking prohibition on the street at any one time. This decrease in average street litter should also reduce the amount of material carried into catch basins or the sewer, an additional cost benefit.

The local governmental agency should evaluate the entire solid waste removal system to determine the optimum conditions in terms of minimizing potential pollution.

Section 8

Responsibilities and Guidelines for the Elimination or Reduction of the Pollution Potential of Urban Environment Wastes

The studies undertaken have evaluated the nature of environmental wastes, determined their amounts and compositions in representative test areas, analyzed them to determine the constituents which create the pollution potential and have correlated these pollutants with those emanating from sewers.

No translation of such urban wastes into water pollution potential could be made without an evaluation of the governmental operations that cope with these environmental wastes, including street cleaning practices, sewer system maintenance, public sanitation ordinances, and regulations of drainage policies. Thus, the study covered the causes as well as the effects of the conditions under investigation. It brought to light specific guidelines for the correction of urban conditions which create the water pollution hazard, *small though it may be in its overall impact* on the total pollution loading of receiving waters.

In the recording of the findings of the various studies, it followed that the details of the test procedures and the step-by-step evaluation methods would be described. This type of information has been set forth in detail, not only to validate the findings and recommendations emanating from the project, but to inform public officials on how they can carry out similar investigations under the specific conditions of their own environments and public and governmental actions and policies.

Thus, this report offers other governmental jurisdictions two alternatives: to retrace the research procedures under local conditions, or by translation and interpolation to apply the basic research facts to their own data.

In this way, this project has fulfilled several current needs: The need for accumulation of reliable field data regarding existing pollution resulting from storm sewer and combined sewer discharges; the need for making knowledge concerning pollution of storm-water runoff available to cities and responsible public officials; and the need for a source of facts which constitute a portion of the research necessary to make an impact on the existing pollution of this country's lakes and streams.

However, the primary value of the study findings is that the facts automatically impose the challenge to do something about them, to the extent that the importance of the problem merits such action in terms of costs versus benefits to be derived. The fact that corrective actions will produce a cleaner environment in which to live, while it achieves a reduction in the pollution potential of urban wastes, lifts these actions above a mere dollar-and-cents evaluation of their benefits.

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Section 9

Acknowledgements

The American Public Works Association is deeply indebted to the following persons and their organizations for the services they rendered to the APWA Research Foundation in carrying out this study for the Federal Water Pollution Control Administration. Without their cooperation and assistance the study would not have been possible.

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Project No. 120

The Causes and Remedies of Water Pollution From Surface Drainage of Urban Areas

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APWA FOREWORD

As Contained In Original Printing

The detailed report which follows gives the results of studies made by the APWA Research Foundation under contract with the Federal Water Pollution Control Administration, and the findings and recommendations resulting therefrom. The concept behind these studies was to determine what possible effects better urban housekeeping might have on the quality of urban storm water runoff.

The field studies were in the main carried out in the City of Chicago with the direct help of its public officials. The city's help on this investigation has been of the highest order and without the help received, the study would not have been possible. Further insight into problems and practices in urban environmental sanitation on a national scale was obtained by searching studies of the literature and by data obtained from respondent cities on a number of questionnaire surveys. The cooperation of these municipalities and their officials is acknowledged.

The conditions and practices analyzed are typical of those found in many other communities throughout the nation. The concept of relating municipal sanitation practices to water pollution is new and in only isolated localities have local governmental agencies considered the impact on receiving waters caused by pollution from urban storm water runoff.

Within the coming years, as the current programs to abate pollution become effective, more attention will be focused on "secondary" sources, such as combined sewer overflows and storm water discharges. Effective urban housekeeping will be a key factor in the correction of both these sources of pollution. Sight must not be lost, however, of the immediate benefits which can be gained by increasing the level of urban housekeeping over and above the possible benefits to preserving the usefulness of our water resources. Municipal cleanliness is an important factor in preventing neighborhood deterioration and in nurturing the pride residents take in their community.

The APWA Research Foundation has appreciated the opportunity to serve the FWPCA on this project.

SAMUEL S. BAXTER, Chairman
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Section 10

Appendices

A. Street Refuse Test Areas and Additional Correlations

B. Supplemental Information Regarding the Amount and Nature of Sheet Refuse Collected from Eighteen Test Areas in Chicago, Illinois

C. Salt Concentration in Expressway Runoff Test

D. Survey Questionnaires Used and Guidelines for their Evaluation

E. Special Analyses Made

F. Abstract of Ordinances Designed to Reduce the Pollution Potential of Urban Wastes

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Appendix A

Street Refuse Test Areas and Additional Correlations

The following pages describe in words and pictures the eighteen areas selected for sampling. The commercial areas (1, 2, and 3) are typical of neighborhood shopping districts in large metropolitan areas, and the downtown central business district of smaller jurisdictions. The industrial areas (4 and 19) are typical of intense and undeveloped areas respectively. The multi-family residential areas (7, 8, 9, 10, 11, 12, 13, 14 and 15) vary from well-kept apartments (9, 10, and 15) to high-rise apartments (14) to very low-income areas (7 and 13). The single family residential areas (5, 6, 16, 17 and 18) varied from estates (16 and 17) to modern suburban (5) to older, well-established middle income housing (6 and 18). Thus a good cross section of characteristics of urban land use was sampled. Figure A-1, Key Map Street Refuse Testing Program, indicates the general location of the 18 test areas, designated by their identification number, and the nine control areas which were machine-swept every two weeks, alphabetically identified.

Index of Land Use Allowed by Zoning Classification

R-1	One-family detached dwelling
R-2	Includes two-family dwelling
R-4	Includes colleges, apartment hotels
R-5	Same as R-4
R-8	Includes restaurants and retail food shops
B3-3	Dwelling units not allowed on ground floor, business other than wholesale distributors, all commercial activity within building
M1-2 & M2-3	Manufacturing not classified as "heavy"

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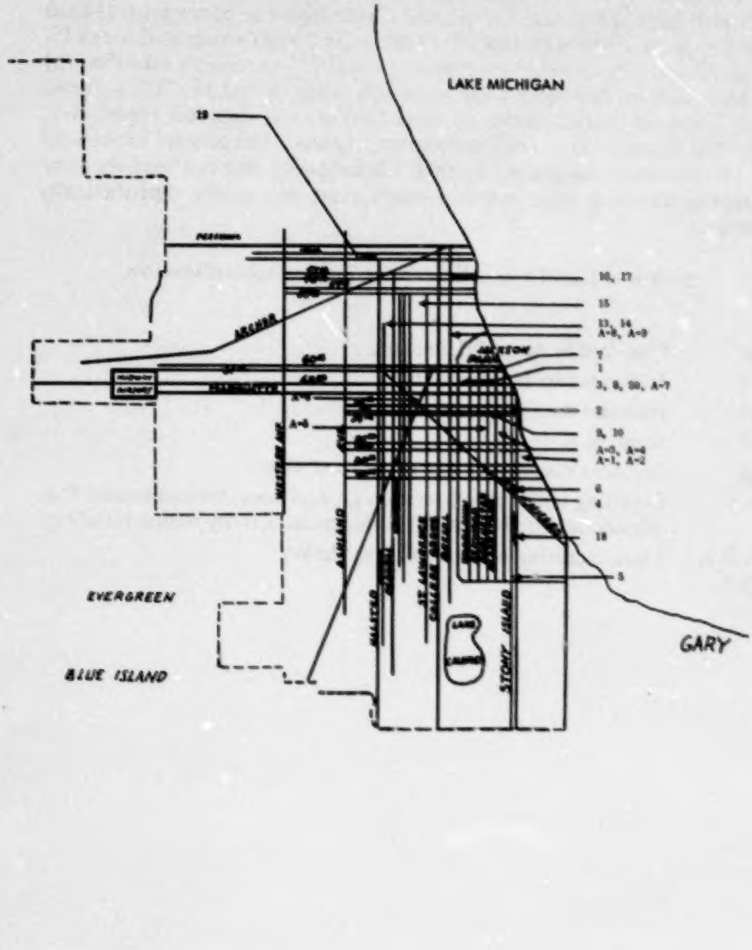
FIGURE A-1 Key Map, Street Litter Test Areas (1 to 10 and 13 to 20 hand swept A-1 to A-9 machine swept)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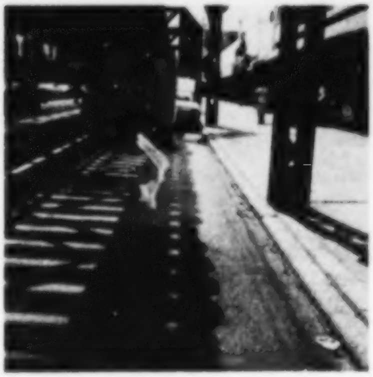
19
ARCHER
JACKSON PARK
16, 17
15
13, 14
A-8, A-9
7
1
3, 8, 20, A-7
2
9, 10
A-3, A-4
A-1, A-2
6
4
18
5
A-6
A-5
WESTERN AVE
ASHLAND
HALSTED
ST LAWRENCE
STONY ISLAND
EVERGREEN
BLUE ISLAND
GARY



AREA No. 1

North Side - 63 Street Ellis to Drexel

Estimated average daily traffic - 7,950

Zoning B3-3

The street is lined with active commercial stores. Elevated rapid transit tracks is overhead. The street was swept daily. The curb and gutter was installed immediately prior to beginning the test and the pavement in the parking land was completely replaced so that the surface was relatively smooth and in excellent condition.

FINDINGS:

Average amount
Litter:
4.15 lb/day/100 ft of curb

Dust and Dirt:
2.53 lb/day/100 ft of curb

BOD: 5.05 mg/g

COD: 26.7 mg/g

AREA NO. 2

East Side - Stony Island,
68th - 69th Street

Estimated average daily traffic - 20,400

Zoning B3-3

The street is a heavily traveled arterial with many small commercial stores on the ground floor of apartment buildings. The street was swept daily.

FINDINGS:

Average Amounts
Litter:
8.05 lb/day/100 ft of curb

Dust and Dirt:
6.19 lb/day/100 ft of curb

BOD: 4.03 mg/g

COD: 24.8 mg/g

AREA NO. 3

West half of the inter-section of 63rd and Stony Island

Zoning B4-3

An extremely congested corner with heavy traffic and a great number of pedestrians transferring between busses and the terminal of the rapid transit station. The street was swept twice a day - early morning and at noon.

FINDINGS:

Average amount
Litter:
3.81 lb/day/100 ft of curb

Dust and Dirt:
1.35 lb/day/100 ft of curb

BOD: 14.54 mg/g

COD: 66.7 mg/g

AREA NO. 4

South Side - South Chicago Avenue, Jeffery to Clyde

Estimated average daily traffic - 11,140

Zoning M1-2

This is a major arterial street in an industrial area. Parking is general. Pavement is in fair condition. There is relatively minor residential traffic. Some unpaved parking areas in vicinity. The street was swept daily.

FINDINGS:

Average amount
Litter:
5.8 lb/day/100 ft of curb

Dust and Dirt:
5.37 lb/day/100 ft of curb

BOD: 2.95 mg/g

COD: 2.30 mg/g

AREA NO. 5

East Side - East End, 91st Place to 92nd Place

Minimum traffic

Zoning R-2

A relatively modern, high class, single family residential area. The street was swept twice a week.

FINDINGS:

Average amount
Litter:
0.45 lb/day/100 ft of curb

Dust and Dirt:
0.36 lb/day/100 ft of curb

BOD: 1.72 mg/g

COD: 18.3 mg/g

AREA NO. 6

North Side - 81st Street, Bennet to Jeffery

Estimated average daily traffic - 1,000

Zoning R-2

An area developed with single family homes, built several years ago and occupied by families of middle level income. The street was swept twice a week.

FINDINGS:

Average amounts
Litter:
1.2 lb/day/100 ft of curb

Dust and Dirt:
0.61 lb/day/100 ft of curb

BOD: 9.1 mg/g

COD: 53.1 mg/g

AREA NO. 7

East Side - Blackstone, 60th Street to 61st, and 61st - Blackstone to Dorchester

Estimated average daily traffic - 700

Zoning R-5

The street is on a bus route, and no parking is allowed along the major portion of the test area. Abutting the street is a power generating plant, a small neighborhood grocery store, several marginal commercial establishments, and apartments with occupants in a low income level. The street was swept twice a week.

FINDINGS:

Average amounts
Litter:
4.7 lb/day/100 ft of curb

Dust and Dirt:
2.30 lb/day/100 ft of curb

BOD: 2.18 mg/g

COD: 50.7 mg/g

AREA NO. 8

East Side - Kenwood, 60th to 61st Street

Estimated average daily traffic - 1,980

Zoning R-8

The abutting property is used for apartments for persons with low income level. The street is one-way and is normally congested with long term parking. Pavement is deteriorating. Yards are well maintained. Street was cleaned twice a week.

FINDINGS:

Average amounts
Litter:
1.5 lb/day/100 ft of curb

Dust and Dirt:
2.81 lb/day/100 ft of curb

BOD: 2.81 mg/g

COD: 29.5 mg/g

AREA NO. 9

North Side - Marquette Road, Stony Island to Blackstone

Estimated average daily traffic - 5,860

Zoning R-5

The street is a collector with heavy traffic. There is a hamburger stand with a high volume of traffic and a large amount of litter associated with a carry-out business. At one end of the test area the stand has employees who daily clean discarded paper for several hundred feet. The street was swept twice per week.

FINDINGS:

Average amounts
Litter:
2.65 lb/day/100 ft of curb

Dust and Dirt:
1.54 lb/day/100 ft of curb

BOD: 4.77 mg/g

COD: 61.3 mg/g

AREA NO. 10

North Side - Marquette Road, Minerva to Greenwood

Estimated average daily traffic - 5,860

Zoning R-4

This portion of Marquette Road is about one-fourth (¼) mile from area No. 10. Abutting development is well kept apartments in an area populated by persons with low level income. The street was swept twice a week.

FINDINGS:

Average amounts
Litter:
1.6 lb/day/100 ft of curb

Dust and Dirt:
1.18 lb/day/100 ft of curb

BOD: 2.9 mg/g

COD: 32.6 mg/g

AREA NO. 13

East Side - Federal, 51st to 53rd Street

Estimated average daily traffic - 1,828

Zoning R-4

Abutting the street on one side is a railroad right-of-way and the other a high-rise Chicago Housing Authority project, set well back from the street. Heavy parking on the street with considerable turn-over. The street was cleaned twice a week.

FINDINGS:

Average amounts
Litter:
3.5 lb/day/100 ft of curb

Dirt and Dust:
2.3 lb/day/100 ft of curb

BOD: 2.03 mg/g

COD: 34.0 mg/g

AREA NO. 14

East Side - Dearborn, 54th to Garfield

Minimum traffic

Zoning R-4

One side of the street is the rear of a school, and the other side has deteriorated multi-family apartments. The street was cleaned twice per week.

FINDINGS:

Average amounts
Litter:
4.85 lb/day/100 ft of curb

Dust and Dirt:
2.55 lb/day/100 ft of curb

BOD: 6.32 mg/g

COD: 45.6 mg/g

AREA NO. 15

North Side - 51st Street, St. Lawrence to Cottage Grove

Estimated average daily traffic - 14,070

Zoning R-5

An arterial street with a grassed parking area. The street is lined with three-story, well-maintained apartment buildings adjacent to a rapidly deteriorating area. Generally the street pavement is in good condition but the curbs are deteriorating. The street was cleaned twice per week.

FINDINGS:

Average amounts
Litter:
4.9 lb/day/100 ft of curb

Dust and Dirt:
2.80 lb/day/100 ft of curb

BOD: 2.28 mg/g

COD: 24.6 mg/g

AREA NO. 16

East side -- Woodlawn, 48th to 49th Street

Zoning R-1

An area of large homes and some professional offices, one block South of a commercially developed area along 47th Street. There is a wide grass area adjacent to the street. All day parking is general. Heavy accumulations of grass and leaves is common. The street was cleaned weekly.

FINDINGS:

Average amount
Litter:
6.8 lb/day/100 ft of curb

Dust and dirt:
0.36 lb/day/100 ft of curb

BOD:
3.24 mg/g

COD:
24.5 mg/g

AREA NO. 17

North side -- 48th Street, Woodlawn to Kenwood

Minimum daily traffic

Zoning R-1

An area adjacent to and similar to area No. 16, developed with multi-family apartments for persons with medium to high income. The street pavement is in good condition. Many trees and large grassed areas are adjacent to the street. The street was cleaned weekly.

FINDINGS:

Average amount
Litter:
0.9 lb/day/100 ft of curb

Dust and dirt:
0.37 lb/day/100 ft of curb

BOD:
9.43 mg/g

COD:
72.8 mg/g

AREA NO. 18

East side – Jeffrey, 89th to 91st Street

Est. average daily traffic 17,300

Zoning R-2

Jeffrey is a collector street with a relative large vehicle count. Bus lines operate on the street. Most of the dwellings are single family residential units constructed several years ago and are well maintained. Street was swept twice per week.

FINDINGS:

Average amount
Litter:
3.5 lb/day/100 ft of curb

Dust and dirt:
1.82 lb/day/100 ft of curb

BOD:
1.94 mg/g

COD:
32.1 mg/g

AREA NO. 19

East side -- Union, Pershing Road to 41st Street

Minimum traffic

Zoning M2-3

The concrete pavement is distressed. Over large areas, rain water washes large amounts of dirt and gravel onto the street surface. There is no development on either side and the streets are not used for parking. Area is adjacent to the Stockyards Industrial area. Street litter was so heavy that difficulty was encountered in handling the material and the findings of the analysis were not generally used. In addition to the dust and dirt, large amounts of rock were found.

FINDINGS:

Average amount
Litter:
16.5 lb/day/100 ft of curb

Dust and dirt:
10.16 lb/day/100 ft of curb

BOD:
2.82 mg/g

COD:
31.8 mg/g

AREA NO. 20

East side -- Kimbark, 60th to 61st Street

Est. average daily traffic 1,620

Zoning R-5

Abutting the one-way street are 3-story apartment buildings in a rapidly deterriorating area. The area is adjacent to area No. 8, although the exterior appearance of the buildings and the level of maintenance of the yards is superior. The street was cleaned weekly.

FINDINGS:

Average amount
Litter:
4.8 lb/day/100 ft of curb

Dust and dirt:
2.90 lb/day/100 ft of curb

BOD:
3.22 mg/g

COD:
34.6 mg/g

Correlations

Figures A-2 and A-3 show the frequency of observed values of 5-day BOD and COD from the street litter dust and dirt samples.

Figures A-4 through A-9 show the average amounts per week of the major components of street litter collected from test areas Nos. 1 through 6.

Figure A-10 compares the average amount per day per 100 feet of curb of street litter for area Nos. 1 through 8, by dust and dirt, paper, inorganic, and total amount.

FIGURE A-2 Frequency Distribution of Observed 5-Day BOD

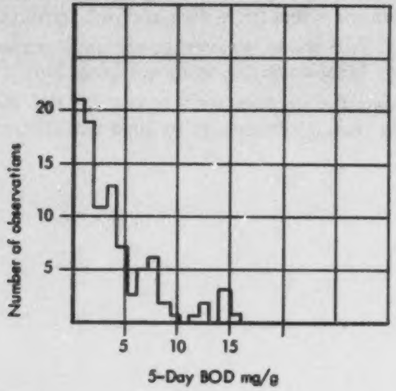


FIGURE A-3 Frequency Distribution of Observed COD

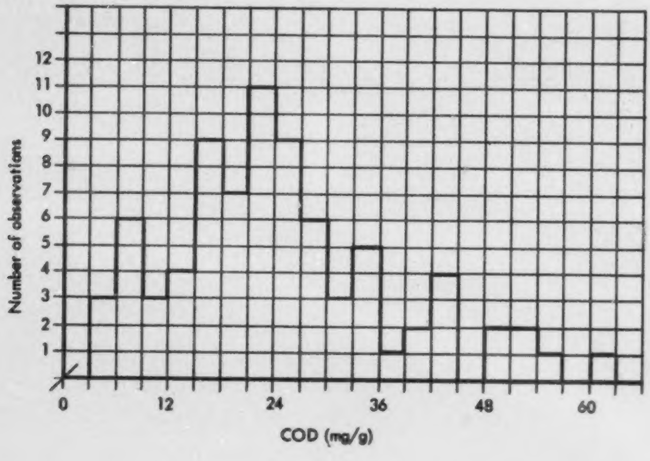


FIGURE A-4 Average Amount of Street Litter Components by Week
Area No. 1

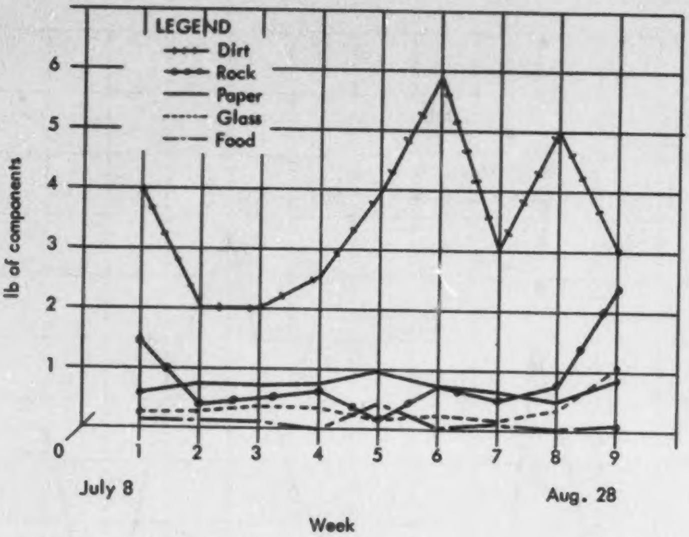


FIGURE A-5 Average Amount of Street Litter Components by Week
Area No. 3

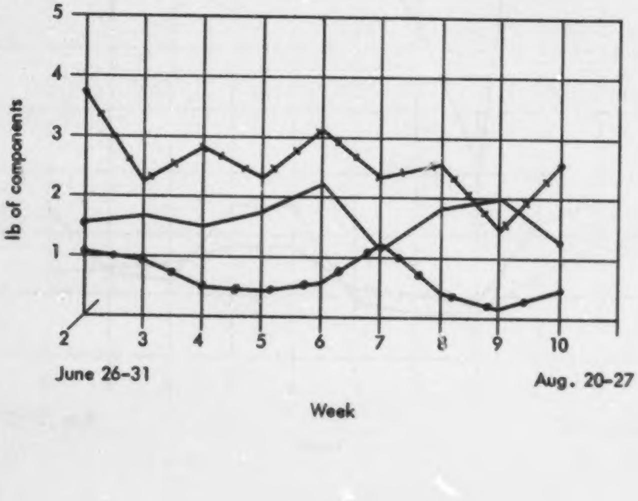


FIGURE A-5 Average Amount of Street Litter Components by Week
Area No. 2

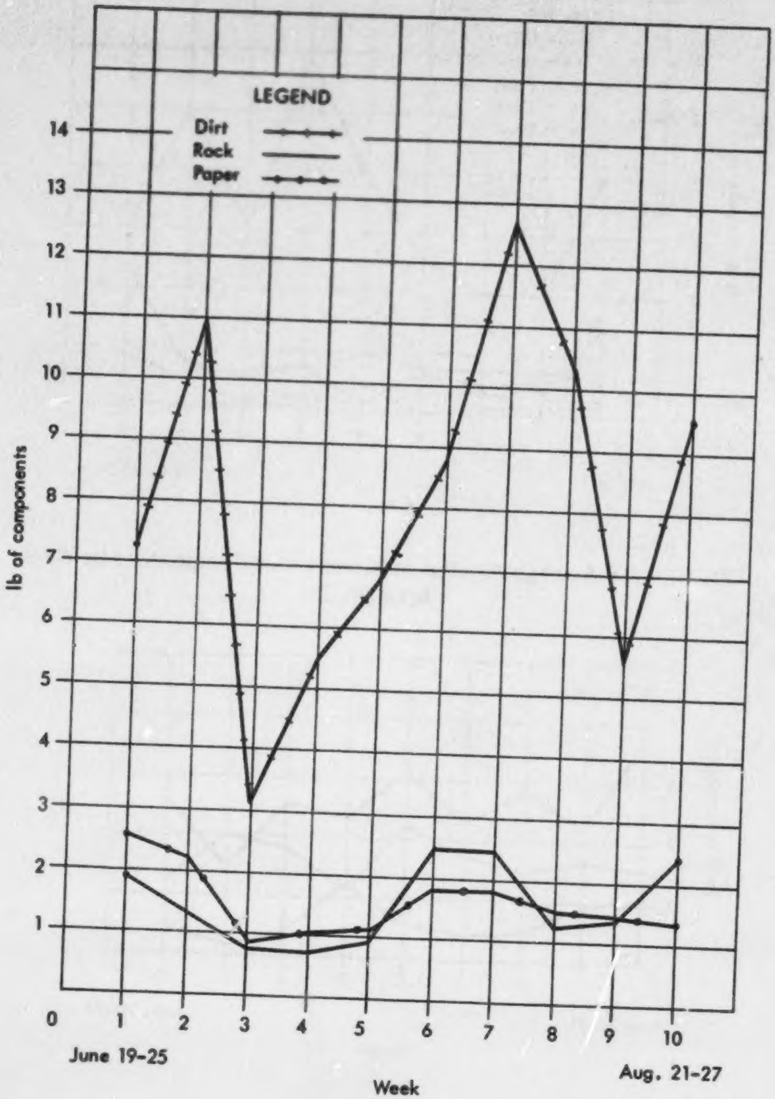


FIGURE A-7 Average Amount of Street Litter Components by Week
Area No. 4

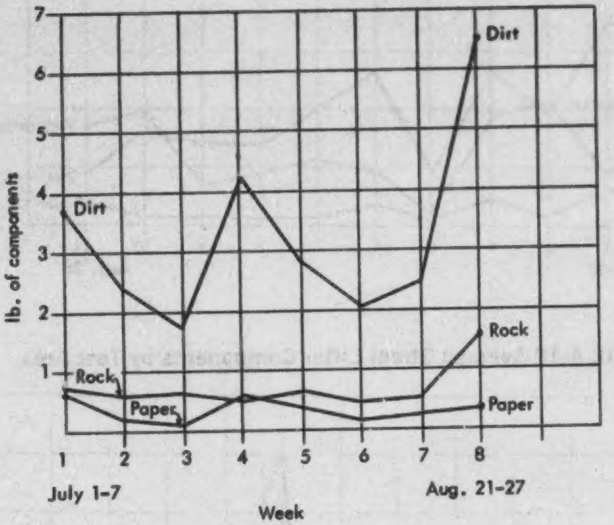


FIGURE A-8 Average Amount of Street Litter Components by Week
Area No. 5

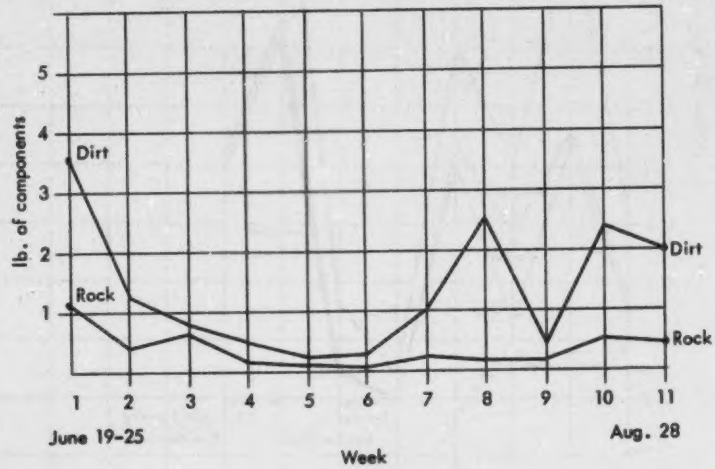


FIGURE A-9 Average Amount of Street Litter Components by Week Area No. 6

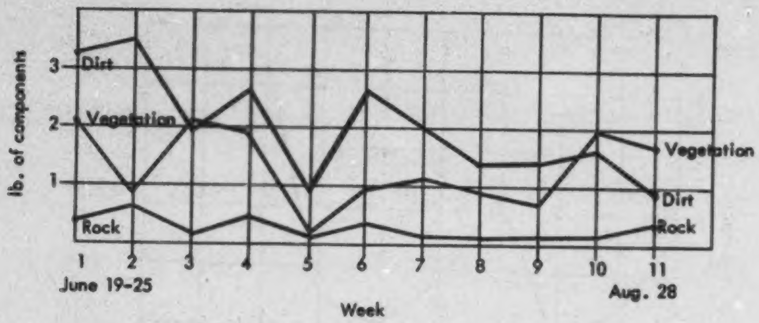
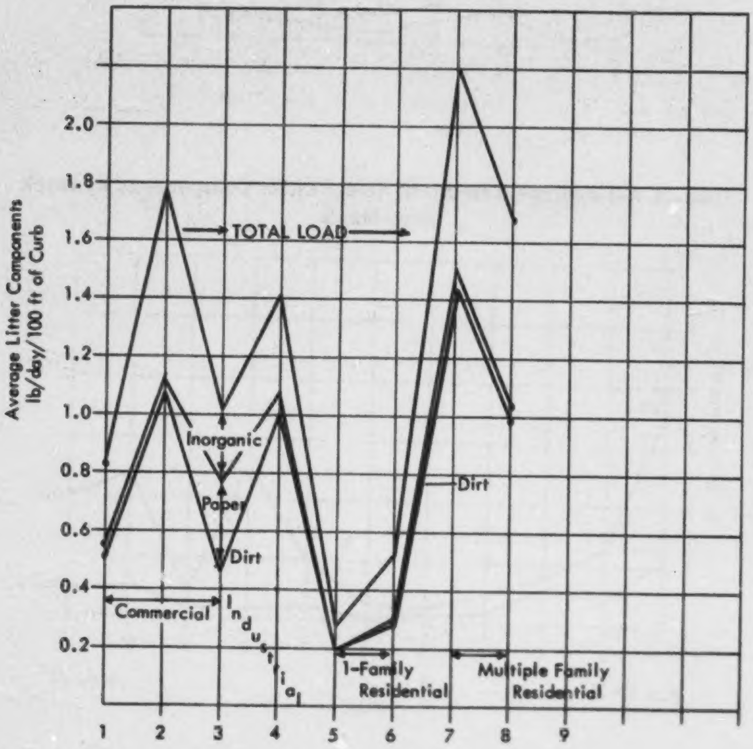


FIGURE A-10 Average Street Litter Components by Test Area



Appendix B

Supplemental Information Regarding the Amount and Nature of Street Refuse Collected from Eighteen Test Areas in Chicago, Illinois

Table B-1 Rainfall During Street Sweeping Tests—June 19, 1968 to August 29,1968

Table B-2 Summary of Laboratory Reports on Street Refuse Components

TABLE B-1. Rainfall During Street Sweeping Tests - June 19, 1968 to August 29, 1968

		Rainfall		
Date 1967	Day of Week	Total @ Woodlawn inches	Total Time @ Midway hrs.	Start-Finish (may not be continuous)
June 20	Tues.	.10	1.08	2:14- 3:19 AM
21	Wed.	.86	8.08	7:20- 5:05 PM
24	Sat.	.49	2.47	11:01- 6:10 PM
27	Tues.	.03	3.35	5:24- 9:24 PM
28	Wed.	.63	4.23	3:37- 8:34 AM
July 1	Sat.	.01	3.00	4:02-11:40 PM
2	Sun.	.10	1.68	12:05- 4:18 PM
9	Sun.	.63	5.58	4:18-12 Mid.
10	Mon.	.02	4.57	12 Mid.- 1:10 PM
18	Tues.	.23	1.63	11:16- 2:20 PM
23	Sun.	.60	2.70	4:23-10:43 AM
26	Wed.	.37	5.53	10:45-11:40 PM
27	Thur.	.09	4.95	3:01-12 Mid.
Aug. 2	Wed.	.23	1.78	6:02- 7:02 PM
3	Thur.	.04	3.63	8:22- 8:40 PM
8	Tues.	.28	6.87	1:01-10:40 PM
18	Fri.	1.33	4.57	3:30- 6:40 PM
19	Sat.	.41	7.72	8:03- 6:20 PM
27	Sun.	.16	6.60	3:00- 3:20 PM

TABLE B-2. Summary of Laboratory Reports on Street Refuse Components

Note: All measurements based on amount per gram of dry material

Test Area	Date	Sample	Water Soluble (mg/g)	Volatile Water Soluble (mg/g)	Difference (Inorg.) (mg/g)	Phos-Phate As PO_4 (mg/g)	Moisture & Volume (%)	5 Day BOD (mg/g)	20 day BOD (mg/g)	COD (mg/g)	Plate Count Colonies/g x 1000	Coliform Organism (mpn/g) x 1000	Fecal Entero-cocci (mpn/g)	Total Nitrogen as N (mg/g)
1	6/19-23	1	8.0	3.4	4.6	< .02	1.3	5.0	6.0	25.0	25.0	1.6	6	-
1	7/ 3- 7	10	6.74	3.44	3.3	< .04	3.79	3.04	-	23.0	820.0	183.6	0	-
1	7/17-21	29	14.2	7.0	7.2	.052	2.5	7.0	-	32.2	46,400.0	11,000.0	420	.3
1	7/31-8/3	38	7.48	3.96	3.52	< .01	1.64	1.9	-	24.0	64,000.0	4,600.0	2,200	.828
1	8/14-17	75	13.48	8.44	5.02	.07	1.27	8.32	-	29.2	4,800.0	1,500.0	2,200	.311
	Ave., Area 1		9.98	5.25	4.73	.038	2.1	5.05	-	26.7	23,209.0	3,456.9	965	.48
2	7/ 3- 7	2	6.2	3.3	2.9	< .02	2.62	4.1	5.1	24.5	110.5	1.6	2	-
2	7/ 3- 7	5	7.6	4.5	3.1	.04	3.0	3.2	4.0	34.4	60.0	21.8	2	-
2	7/17-21	18	10.4	5.14	5.26	< .04	1.76	3.84	-	15.0	1,188.0	321.8	-	-
2	7/20-23	7	5.4	3.0	2.4	< .04	2.83	2.2	2.6	30.8	30.0	18.8	10	-
2	7/31-8/4	39	7.04	4.18	2.86	.015	.96	1.9	-	15.5	7,200.0	93.0	180	.34
2	8/14-17	76	14.2	8.64	5.56	< .01	.82	8.96	-	30.2	4,400.0	3,000.0	-	.306
	Ave., Area 2		8.47	4.79	3.68	.027	1.87	4.03	-	24.8	2,163.4	576.2	32	.323
3	6/19-23	6	16.0	7.2	8.8	.04	6.23	7.0	7.8	38.8	64.0	14.0	2	-
3	7/ 3- 7	69	9.78	4.78	5.0	.06	8.2	4.96	-	63.8	3,440.0	2,400.0	-	.352
3	7/11-14	8	11.6	5.8	5.8	.04	3.12	5.4	6.5	33.6	44.0	21.8	3	-
3	7/17-21	70	13.98	7.0	6.98	.08	4.95	7.52	-	42.8	600.0	400.0	-	.282
3	7/31-8/4	40	19.7	11.8	7.9	.084	4.17	19.5	-	22.0	52,800.0	2,100.0	14	.598
3	8/14-17	77	43.36	28.18	15.18	.55	2.78	42.88	-	209.1	25,000.0	1,200.0	8	.597
	Ave., Area 3		19.07	10.78	8.29	.142	4.91	14.54	-	66.7	9,908.0	1,022.6	4	.457
4	6/19-23	3	4.4	1.4	3.0	< .02	3.01	7.3	8.2	42.0	80.0	1.6	1	-
4	6/26-30	9	3.4	1.7	1.7	< .04	3.29	.8	1.2	19.3	32.0	28.2	10	-
4	7/ 3- 7	4	5.6	2.7	2.9	< .02	.54	4.5	6.0	24.1	50.0	1.6	4	-
4	7/17-21	19	6.9	2.8	4.1	.08	.75	1.0	-	13.8	150.0	18.0	3	-
4	7/31-8/4	41	4.3	2.39	1.96	< .01	1.99	1.3	-	24.7	33,000.0	400.0	56	.45
4	8/14-17	78	7.54	4.2	3.34	< .01	1.13	2.98	-	14.3	2,640.0	1,500.0	86	.412
	Ave., Area 4		5.36	2.53	2.83	.03	1.79	2.95	-	23.0	5,992.0	324.9	27	.431
5	6/21, 26	50	2.44	1.0	1.44	< .01	8.08	1.44	-	11.9	1,000.0	110.0	86	.125
5	7/3, 5, 14	42	3.7	1.54	2.16	< .01	8.1	.8	-	19.1	22,400.0	2,100.0	280	.598
5	7/17, 20, 24, 27	20	2.8	1.3	1.5	< .04	2.36	.6	-	11.7	3,040.0	141.0	10	

TABLE B-2. Summary of Laboratory Reports on Street Refuse Components (Cont'd)

Note: All measurements based on amount per gram of dry material

Test Area	Date	Sample	Water Soluble (mg/g)	Volatile Water Soluble (mg/g)	Difference (Inorg.) (mg/g)	Phosphate As PO_4 (mg/g)	Moisture & Volume (%)	5 Day BOD (mg/g)	20 day BOD (mg/g)	COD (mg/g)	Plate Count Colonies/g x 1000	Coliform Organism (mpn/g) x 1000	Fecal Enterococci (mpn/g)	Total Nitrogen as N (mg/g)
5	7/31, 8/3, 7	51	3.24	1.64	1.6	<.01	11.17	4.8	-	36.4	2,400.0	1,100.0	186	.308
5	8/14, 17, 21, 24	79	3.52	1.54	1.98	.04	4.82	.96	-	12.4	3,300.0	1,800.0	86	.27
	Ave., Area 5		3.1	1.4	1.7	.02	5.75	1.72	-	18.3	6,428.0	1,050.2	130	.325
6	6/20-30	21	3.4	1.6	1.8	.04	4.46	1.7	-	25.4	3,600.0	109.0	4	-
6	7/4, 7, 11, 14	11	12.2	7.96	4.24	.04	9.34	15.5	-	83.8	500.0	133.6	-	-
6	7/21, 25, 28	64	7.84	5.66	2.18	.11	2.39	9.44	-	54.1	7,680.0	1,750.0	-	.366
6	8/1, 4, 8, 11	52	6.64	2.28	4.36	.072	3.28	4.16	-	36.9	9,600.0	1,500.0	14	.238
6	8/15, 18, 22, 25	80	10.3	7.42	2.88	.09	11.93	14.8	-	65.2	3,440.0	2,100.0	186	.967
	Ave., Area 6		8.08	4.98	3.1	.07	4.28	9.1	-	53.1	4,964.0	1,128.5	41	.523
7	6/19, 21, 26	53	3.0	1.52	1.48	.024	2.95	1.36	-	32.4	2,240.0	1,100.0	420	.8
7	7/3, 5, 13	43	4.3	2.2	2.1	<.01	4.43	1.4	-	41.8	20,000.0	1,100.0	860	.51
7	7/17, 19, 24	54	4.72	2.16	2.56	.016	5.79	2.4	-	106.4	3,040.0	2,400.0	2,200	.394
7	7/31, 8/4, 8, 11	55	8.82	3.54	5.28	.48	3.84	3.0	-	36.7	2,560.0	1,100.0	22	.51
7	8/15, 21, 24	81	5.06	1.78	3.28	.18	2.67	2.72	-	36.0	1,600.0	1,000.0	-	.403
	Ave., Area 7		5.18	2.45	2.73	.142	3.94	2.18	-	50.7	5,888.0	1,340.0	700	.523
8	6/19, 27	44	4.62	2.98	1.64	.01	1.83	1.4	-	16.5	30,400.0	2,000.0	80	.65
8	7/21, 27	22	4.5	2.4	2.1	<.04	2.88	2.7	-	30.7	2,240.0	141.0	2	-
8	8/4, 11	56	4.68	2.96	1.72	.016	4.53	3.04	-	56.4	8,320.0	900.0	2,200	.448
8	8/18, 25	82	4.52	2.58	1.94	.02	4.12	4.08	-	14.2	2,100.0	1,800.0	8	1.22
	Ave., Area 8		4.58	2.76	1.82	.021	3.34	2.81	-	29.5	10,765.0	1,210.9	572	.773

TABLE B-2. Summary of Laboratory Reports on Street Refuse Components (Cont'd)

Note: All measurements based on amount per gram of dry material

Test Area	Date	Sample	Water Soluble (mg/g)	Volatile Water Soluble (mg/g)	Difference (Inorg.) (mg/g)	Phosphate As PO$_4$ (mg/g)	Moisture & Volume (%)	5 Day BOD (mg/g)	20 day BOD (mg/g)	COD (mg/g)	Plate Count Colonies/g x 1000	Coliform Organism (mpn/g) x 1000	Fecal Enterococci (mpn/g)	Total Nitrogen as N (mg/g)
9	6/19, 21, 26	57	.96	.08	.88	.04	.84	1.28	-	20.5	1,440.0	460.0	8	.144
9	7/3, 5, 13, 14	45	5.06	3.62	1.44	.01	1.83	1.7	-	24.2	70,400.0	11,000.0	3,000	.45
9	7/17, 19, 24, 27	23	6.4	3.8	2.6	< .04	1.69	2.4	-	22.7	1,980.0	141.0	6	-
9	7/31, 8/2, 7, 10	58	12.6	8.56	4.04	.115	2.03	13.12	-	112.6	3,040.0	700.0	8	.698
9	8/14, 17, 21, 24	83	13.68	10.14	3.54	.11	3.62	5.36	-	126.3	4,200.0	1,200.0	-	.594
	Ave., Area 9		7.74	5.24	2.5	.063	2.0	4.77	-	61.3	16,212.0	2,643.8	605	.377
10	6/20, 23, 27, 30	71	2.74	.96	1.88	< .01	10.06	.80	-	28.4	10,080.0	4,600.0	420	.149
10	7/4, 7, 11	72	4.4	2.66	1.74	.048	.79	1.52	-	21.5	1,840.0	230.0	240	.842
10	7/18, 20, 25, 27	24	5.8	3.3	2.5	< .04	1.72	2.1	-	30.5	1,520.0	70.0	10	-
10	8/1, 4, 10	59	8.5	6.04	2.46	.04	1.0	4.96	-	36.6	4,960.0	2,100.0	86	.312
10	8/14, 17, 22, 25	84	7.58	4.94	2.64	.01	1.02	5.12	-	46.0	2,580.0	1,100.0	186	.318
	Ave., Area 10		5.8	3.58	2.22	.03	2.92	2.9	-	32.6	4,196.0	1,620.0	188	.405
13	6/20	46	3.16	1.8	1.36	< .01	6.87	.7	-	36.7	48,000.0	3,000.0	860	1.2
13	7/5, 11	30	3.44	1.26	2.18	< .01	.9	1.5	-	34.0	30,400.0	9,300.0	460	.598
13	7/18, 25	25	3.2	1.9	1.3	< .04	1.21	2.4	-	33.1	1,760.0	94.0	10	-
13	8/1, 8	60	2.56	1.3	1.26	< .01	.79	1.4	-	34.9	4,480.0	2,100.0	-	.98
13	8/15, 22	73	5.72	3.18	2.54	.05	1.98	4.16	-	31.2	1,200.0	800.0	-	.602
	Ave., Area 13		3.62	1.89	1.73	.024	2.35	2.03	-	34.0	17,168.0	3,058.8	266	.845
14	6/20, 27	12	2.96	1.36	1.6	< .04	6.22	1.76	-	34.7	490.0	183.6	-	-
14	7/5, 11	31	9.88	6.36	3.52	.135	6.68	7.7	-	15.0	96,000.0	24,000.0	-	.77
14	7/18, 25	26	11.4	7.1	4.3	< .04	2.25	15.4	-	71.6	1,360.0	109.0	4	-
14	8/1, 8	61	5.36	3.42	1.94	.08	1.49	4.48	-	67.0	2,240.0	700.0	-	866
14	8/15, 22	85	5.62	2.74	2.88	.07	2.33	2.24	-	39.7	5,500.0	29,000.0	2,200	.373
	Ave., Area 14		7.04	5.2	1.84	.073	3.79	6.32	-	45.6	21,118.0	5,578.5	451	.67

TABLE B-2. Summary of Laboratory Reports on Street Refuse Components (Cont'd)

Note: All measurements based on amount per gram of dry material

Test Area	Date	Sample	Water Soluble (mg/g)	Volatile Water Soluble (mg/g)	Difference (Inorg.) (mg/g)	Phosphate As PO_4 (mg/g)	Moisture & Volume (%)	5 Day BOD (mg/g)	20 day BOD (mg/g)	COD (mg/g)	Plate Count Colonies/g x 1000	Coliform Organism (mpn/g) x 1000	Fecal Enterococci (mpn/g)	Total Nitrogen as N (mg/g)
15	6/23	47	2.74	1.92	.62	.01	6.87	1.1	-	20.4	67,200.0	15,000.0	1,500	.34
15	7/7, 14	13	9.16	6.02	3.14	< .04	11.46	3.68	-	31.2	900.0	321.8	-	-
15	7/21, 28	32	4.8	2.76	2.04	< .01	1.43	2.4	-	23.8	27,800.0	900.0	80	.54
15	8/4, 11	62	3.66	2.3	1.36	.032	1.79	2.56	-	25.9	3,680.0	2,300.0	8	.7
15	8/18, 25	86	6.02	3.56	2.46	.02	.82	1.68	-	21.7	3,820.0	2,100.0	420	2.266
	Ave., Area 15		5.28	3.31	1.97	.02	4.48	2.28	-	24.6	20,680.0	4,122.4	402	.961
16	7/6, 13	14	5.06	3.04	2.02	< .04	2.16	2.24	-	22.0	2,000.0	321.8	-	-
16	7/20, 28	33	5.48	3.28	2.2	.015	15.2	4.1	-	8.5	36,800.0	460.0	4,800	.8
16	8/3, 10	63	2.96	1.94	1.02	< .01	7.27	2.64	-	31.5	3,440.0	1,300.0	-	.322
16	8/17, 24	87	6.26	3.94	2.32	.03	1.48	4.0	-	36.0	3,080.0	2,000.0	46	.453
	Ave., Area 16		4.94	3.06	1.88	.024	6.52	3.24	-	24.5	11,440.0	1,020.5	1,211	.525
17	7/6, 13	15	8.26	5.62	2.64	< .04	1.31	8.01	-	34.7	1,240.0	321.8	-	-
17	7/20, 28	34	6.5	4.5	2.0	.05	9.62	5.7	-	7.8	102,400.0	460.0	4,800	.45
17	8/3, 10	65	5.82	4.1	1.72	.105	2.31	8.0	-	55.3	9,600.0	7,500.0	186	.7
17	8/17, 24	88	15.6	11.82	3.78	.24	2.69	16.0	-	193.5	5,640.0	3,600.0	186	.421
	Ave., Area 17		9.04	6.51	2.53	.109	3.98	9.43	-	72.8	29,720.0	2,970.5	1,293	.523
18	6/21, 29	27	4.0	2.1	1.9	< .04	6.84	2.1	-	28.2	1,200.0	109.0	6	-
18	7/4-12	16	5.24	2.62	2.62	< .04	1.31	1.84	-	30.8	1,140.0	321.8	-	-
18	7/26	28	6.1	3.9	2.2	< .02	2.81	2.4	-	28.4	980.0	28.2	10	-
18	8/3, 10	66	4.02	2.44	1.58	.01	9.92	1.44	-	41.1	6,400.0	1,100.0	46	.482
	Ave., Area 18		4.84	2.79	2.06	.028	5.22	1.94	-	32.1	2,430.0	389.8	15	.482
19	6/19, 26	48	4.56	2.66	1.9	< .01	1.66	.7	-	27.3	40,000.0	9,300.0	780	.31
19	7/3, 11	35	3.78	2.1	1.68	< .01	7.18	3.2	-	30.5	20,800.0	46.0	1,500	.626
19	7/17, 24	36	5.02	2.72	2.3	.032	.78	1.3	-	27.3	59,200.0	1,100.0	140	31
19	7/31, 8/7	67	5.34	3.76	1.58	< .01	.97	6.32	-	50.3	7,680.0	1,500.0	46	.533
19	8/14, 21	74	14.2	8.64	5.56	< .01	.82	2.56	-	23.8	2,200.0	1,000.0	186	.250
	Ave., Area 19		6.58	3.98	2.6	.014	2.28	2.82	-	31.8	25,976.0	2,589.2	530	.41
20	6/30	49	2.7	1.08	1.62	< .01	7.63	.6	-	9.0	98,000.0	230.0	780	.48
20	7/7, 14	17	6.02	4.12	1.9	< .04	2.67	3.84	-	32.2	1,660.0	321.8	-	-
20	7/21, 25	37	5.84	3.92	1.92	.08	1.33	3.8	-	51.7	67,200.0	4,600.0	60	.51
20	8/2, 8	68	3.56	2.34	1.22	< .01	3.02	6.72	-	36.8	1,860.0	430.0	-	.166
20	8/15, 22	89	3.5	1.9	1.6	.02	3.88	1.12	-	43.5	6,200.0	4,800.0	2,200	.27
	Ave., Area 20		4.32	2.67	1.65	.03	3.71	3.22	-	34.6	34,984.0	2,076.4	1,013	.356

Appendix C

Salt Concentration in Expressway Runoff Test

Testing Equipment Used

The sampling equipment used during the salt concentration tests was developed by the personnel of the FWPCA at the Robert A. Taft Sanitary Engineering Research Center, Cincinnati, Ohio. The equipment was field tested during the course of the project. The basic operation of the equipment follows.

- A liquid level pressure gauge is used at an elevation above which height a water sample will be taken
- Upon activation of the liquid level guage, a pump is started which sends a flow of the water to be sampled into the sampling equipment located in a 14 foot camp-type trailer
- Controls allow for the length of time that a sample will be taken and the interval between samples while the liquid level guage is activated
- Samples are taken when a solenoid valve is opened which releases the sample to a rotary arm distributor
- The distributor has 72 positions, controlled by gears and an electrical relay connected to the solenoid valve
- The distributor arm positions in successive order over the 72 positions, each of which is piped to a one-gallon jar located on removable trays in two layers, and
- When the level of the liquid being sampled drops below the liquid level guage the pump is turned off and all equipment cycles to start over again upon activation of the liquid level guage.

The sampling trailer also can be used with a rain indicator in series in the electrical circuit to allow the liquid level guage to be activated only when a predetermined amount of precipitation has accumulated in a collection pan. The unit was built to meet the need for a portable sampling device. Equipment in the trailer would also allow the collection of samples based on the flow past a sampling tube based on the use of equipment developed by the Department of Agriculture. This capability was not tested.

A four channel event recorder was used to monitor the various operations of the sampling cycle in order to determine the validity of a particular sample.

A ring adjacent to the distributor arm had been constructed to hold 72 sterile test tubes for collection of samples for bacteriological sampling. To this end, a refrigeration unit for cooling a water bath for all samples was also provided.

Appendix D

Survey Questionnaires Used and Guidelines for Their Evaluation

As discussed in the text, survey questionnaires were sent to a large number of cities of varying size and geographical distribution to determine local practices and problems in the fields of street refuse, sewer solids, and the use of chemicals. Individual jurisdictions generally received only one of the surveys and the questionnaires were directed to the local official thought to have the information desired.

The questionnaires were so detailed that a poor response was obtained. Three separate followup mailings were made and eventually between 100 and 150 replies to each questionnaire were received.

The responses were separated into five groupings according to the part of the country in which each city was located and then, according to one of five population categories. The five groupings were:

State Groupings

East	South	Midwest	Southwest	West
Connecticut	Alabama	Illinois	Arizona	Alaska
Delaware	Arkansas	Iowa	New Mexico	California
Indiana	Florida	Kansas	Oklahoma	Colorado
Kentucky	Georgia	Minnesota	Texas	Hawaii
Maine	Louisiana	Missouri		Idaho
Maryland	Mississippi	Nebraska		Montana
Massachusetts	North Carolina	North Dakota		Nevada
Michigan	South Carolina	South Dakota		Oregon
New Hampshire	Tennessee	Wisconsin.		Utah
New Jersey				Washington
New York				Wyoming
Ohio				
Pennsylvania				
Rhode Island				
Vermont				
Virginia				
West Virginia				

Copies of the three questionnaires used follow.

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AMERICAN PUBLIC WORKS ASSOCIATION RESEARCH FOUNDATION

SURVEY - LITTER

City ____________ State ____________ Date ____________
Prepared by ____________ Title ____________ Dept. ____________
Mailing Address ____________

A. Please rate the following factors, which may be controlled or altered by the action of public officials, and result in a more attractive waste-free urban community, in their order of importance from 1 to 26 as related to your community. Please use number one (1) to indicate most serious. Use each number once only.

Item	Rating in Order (See A-above)	Check (when applicable) if controlled by existing ordinance	Check (when applicable) if existing ordinance enforced	Check if penalties are accessed on offenders	Check if not a problem in your city
a. Spillage from overloaded trucks					
b. Litter from parades and large public events					
c. Disintegration of poorly surfaced streets					
d. Lack of paving at driveway and alley entrances					
e. Yard refuse (leaves, lawn clippings)					
f. Animal droppings					
g. Deposition from windstorms					
h. Improperly used trash receptacles					
i. Improper storage of household refuse					
j. Debris from construction and demolition					
k. Roadside dumping					
l. Lack of satisfactory street cleaning equipment					
m. Poor refuse collection practices					
n. Street trees, type or placement					
o. Lack of catch basin and storm water inlet maintenance					
p. Air pollution					
q. Droppings from vehicles (grease, oil, etc.)					
r. Poor public cooperation					
s. Lack of adequate public trash receptacles					
t. Lack of public education					
u. Inadequate budget for street cleaning					

v. Other (Specify)					
w. Other					
x. Other					
y. Other					
z. Other					

B. Street Cleaning Frequency (days per week, weekly, monthly, etc.) (Check)

Type Street	Miles as Classified	Total curb miles swept Annually	Frequency designate (daily-weekly-monthly) Flushed	Frequency designate (daily-weekly-monthly) Swept	Year Round	No Winter Sweeping
Residential						
Commercial						
Downtown business						
Arterial (4 or more lanes)						
Industrial						
Park roads						
Private (If applicable)						
Other (specify)						

C. Amount of Street Refuse

1. Area served ______________________ Population served ____________

	Volume Cu. yds.	Weight Tons	(If by City (Check); If by contract - Specify)
Annual amount street refuse removed			
Annual amount from litter recepticles removed			
Annual amount leaves & yard trimmings removed (from streets)			

D. Annual Labor for Street Refuse Removal Period ____________

	Total Hours Labor	Total Hours Equipment
Hand sweeping		
Mechanical flushing		
Mechanical sweeping		
Disposal of sweepings		
Catch basin cleaning		
Litter basket emptying		
Other		
TOTAL		

E. Refuse Sanitation Inspection Activities

1. Inspection activities are carried out by public works department__________ police department __________Health department ________Other______________

2. Number of city refuse sanitation inspectors assigned to:

Type area	Number of equivalent full time employees
Residential	____________
Commercial	____________
Industrial	____________

3. Primary function of inspector is to require proper placement of refuse __________
require proper containers for refuse ____________________
improve customer relations ____________________
enforce collection standards ____________________
other ______________________________

4. Performance of inspector is judged by (title) ____________________

5. Litter control activities are coordinated by (title) ____________________

6. Placement of litter baskets is determined by (title) ____________________

7. (Check one) Private___ Public____ Contract____ Collects contained residential

8. (Check one) Private___ Public____ Contract____ Collects commercial

9. (Check one) Private___ Public____ Contract____ Collection industrial

F. Other comments (if any)______________________________

AMERICAN PUBLIC WORKS ASSOCIATION RESEARCH FOUNDATION

SURVEY – STORM SEWER SOLIDS

City____________________ State____________ Date____________

Prepared by____________________ Title__________ Department____________

Mailing Address____

I. General Information

	Area Serviced (sq. mi.)	Population served	Length Sewers* (Miles)
Sanitary Sewers			
Storm Sewers			
Combined Sewers			
TOTAL			

Average annual rainfall__________ in. Annual average snowfall__________ in.

or__________ equivalent in. of rainfall

(*Omit house connections)

II. Points of solid removal

A. Catch basins

1. Are catch basins used: Yes________ No________
2. Are catch basins currently required on new storm sewers: Yes________ No________
3. Are catch basins cleaned by Sewer Dept. Yes________ No________
   by Street Dept./Div. Yes________ No________ or other (specify)__________
4. Approximate number of catch basins__________
5. Have regular cleaning policy: Yes________ No________
   If yes, please attach copy of policy.
6. Approximate annual volume solids removed__________ cu. yds.
   How determined?________________________________
   What are neighborhood characteristics most effecting amount of solids?
   ____
   ____
   ____
7. Annual: Salaries__________ Equipment__________ Other__________
   Total__________
8. No. and composition of catch basin cleaning crews: Number________ (Describe crew and equipment)________________________________
   ____
   ____
   Total man hours/year____________________
   Frequency of cleaning catch basins____________________ times/year

9. What type of trap do you use on catch basin? ______________________

What was basis for selection of type of trap? ______________________

____

____

Please attach copy of standard drawing.

10. Principal source of solids believed to be from ______________________

____

11. Where and how do you dispose of the solids collected? ______________

____

12. Do you contract with private firms to clean catch basins? Yes ______ No ______

If yes, per cent of work done by contract ________%, annual cost of contract

$ ______________________

B. Sewer Cleaning

	Combined Sewers	Sanitary Sewer	Storm Sewer
1. Estimated infiltration			
(a) gal./in-diam./mile			
(b) total m.g.d. (for the system)			
2. Miles in system			
(a) 6-12" diameter			
(b) 15-24" diameter			
(c) 27-72" diameter			
(d) over			
3. Average volume of solids removed per mile (cu. yds.) per year			

4. Annual equipment and labor

	Crew Size	Man Hours	Type equipment used
Combined			
Sanitary			
Storm			
TOTAL			

5. Volume dry weather flow in storm sewers (m.g.d.) ______________________

C. Overflow diversion chambers on combined systems (answer only for combined sewers)

1. Do you have equipment installed to indicate when overflow occurs?

Yes__________ No__________ If yes, please describe____________________

2. Usual overflow setting:__________X dry weather flow

3. Special maintenance problems encountered____________________

4. Have you determined if there is unused capacity in the interceptor system?

Yes__________ No__________ If yes, how____________________

D. Grit removal

1. Sewage treatment plant has provisions for grit removal. Yes__________ No__________

If yes:

2. Annual volume of solids removed (cu. yds.)____________________

3. Special problems encountered____________________

4. Annual operation cost of grit removal____________________

E. Outfall removal

1. Dredging or other removal activities at sewer outfall required: Yes________ No________

If yes:

2. Frequency of removal (per year)____________________

3. Volume removed (cu. yds./year)____________________

4. Describe nature of material____________________

5. Where is material disposed ______________________________

6. Annual cost ____________________ Annual man hours ____________________

F. Other comments (If any) ______________________________

____

____

____

____

G. For sewer system please check allowable connections for discharge of:

	Combined		Storm		Sanitary	
	Yes	No	Yes	No	Yes	No
Swimming pools	___	___	___	___	___	___
Foundation drains	___	___	___	___	___	___
Roof drains	___	___	___	___	___	___
Sump pump	___	___	___	___	___	___
Cooling water	___	___	___	___	___	___
Ind. process water (treated)	___	___	___	___	___	___
Ind. process water (untreated)	___	___	___	___	___	___

AMERICAN PUBLIC WORKS ASSOCIATION RESEARCH FOUNDATION

SURVEY - USE OF CHEMICALS

City________________________ State________________________ Date__________

Prepared by________________________ Title________________________ Dept.__________

Mailing Address____

A. This report covers the one year period from __________ 196__ to __________ 196__
(The latest annual period for which records are available should be used)

B. Pesticides and insecticides used (exclude rodent control):

Major active Ingredients	Dept. or Activity Using	Pest to be Controlled	Amount used (gal.)	Amount Used in Future to be		Used on		
				Increased	Decreased	Parkway	Public Area	Private Area

C. Herbicides used:

Major active Ingredients	Dept. or Activity Using	Pest to be Controlled	Amount used (gal.)	Amount Used in Future to be		Used on		
				Increased	Decreased	Parkway	Public Area	Private Area

D. Chemical fertilizers used:

Major active Ingredients or Identification	Annual Amount Used (Tons)	Area Covered (Acres)

E. (Check one) This report covers the use of all such chemicals by the city: Yes__________

No__________ If no, to whom would additional copies be sent?____________________

Mailing address____

F. What city official determines the chemical to be used?____________________

G. What city official determines the amount of chemical to be used?____________________

H. On what basis is the type and amount selected?____________________

I. Is there any evidence in your city of stream pollution or fish kill caused by runoff from storm sewers carrying dissolved pesticides, herbicides or fertilizers? Yes________ No________

J. Has any action been taken by the city to eliminate or reduce this pollution or fish kill? Explain____

K. Other comments (if any)____

Appendix E

Special Analyses Made

1. Sieve Analysis of Street Sweeping Tests

Area No.	Date	Screen (USS)	Percent Retained	Specific Gravity
1	June 19 - 23	10	2.66%	3.027
	(hand swept)	16	5.21	2.638
		20	4.06	2.772
		30	5.03	2.676
		Thru 30	82.5	2.588
		Loss	0.54	--

Area No.	Date	Screen (USS)	Percent Retained	Specific Gravity
2	June 19 - 23	10	2.53%	2.578
	(hand swept)	16	5.69	2.364
		20	4.51	2.353
		30	6.23	2.295
		Thru 30	80.2	2.508
		Loss	0.84	--

Area No.	Date	Screen (USS)	Percent Retained	Specific Gravity
3	June 14 - 23	10	12.37%	2.198
	(hand swept)	16	12.35	2.248
		20	6.93	2.381
		30	8.40	2.197
		Thru 30	58.8	2.484
		Loss	1.15	--

Area No.	Date	Screen (USS)	Percent Retained	Specific Gravity
4	June 19 - 23	10	3.45%	2.602
	(hand swept)	16	7.04	2.605
		20	6.43	2.652
		30	12.8	2.637
		Thru 30	69.1	2.488
		Loss	1.21	—

Area No.	Date	Screen (USS)	Percent Retained	Specific Gravity
A-9	August 2	10	58.0%	2.153
	(machine swept)	16	19.0	2.439
		20	2.18	2.876
		30	4.38	2.456
		Thru 30	13.6	2.481
		Loss	2.80	--

Area No.	Date	Screen (USS)	Percent Retained	Specific Gravity
A-3	July 20 (machine swept)	10	22.8%	2.230
		16	66.98	2.354
		20	1.46	2.237
		30	2.10	2.530
		Thru 30	4.03	2.536
		Loss	2.62	--

Area No.	Date	Screen (USS)	Percent Retained	Specific Gravity
A-3	July 5, 19 (machine swept)	10	28.0%	2.301
		16	67.2	2.345
		20	0.57	2.976
		30	0.84	2.867
		Thru 30	1.05	2.118
		Loss	2.28	--

	Screen (USS)	Percent Retained	Specific Gravity
(Vacuum cleaning following machine sweeping)	10	2.47%	2.065
	16	1.71	2.584
	20	0.57	1.938
	30	1.86	2.411
	Thru 30	93.18	2.587
	Loss	0.22	--

	Screen (USS)	Percent Retained	Specific Gravity
(Hand broom following machine sweeping)	10	3.30%	2.202
	16	24.92	2.558
	20	3.35	2.406
	30	6.96	2.409
	Thru 30	59.96	2.295
	Loss	1.50	--

	Screen (USS)	Percent Retained	Specific Gravity
(Vacuum cleaning following machine sweeping)	10	1.02%	2.002
	16	4.16	1.902
	20	3.86	2.131
	30	18.34	2.344
	Thru 30	72.10	2.187
	Loss	0.52	--

Area		Screen (USS)	Percent Retained	Specific Gravity
Michigan Ave. East Side	(Machine swept)	10	4.57%	2.251
		16	8.83	2.731
		20	4.96	2.226
		30	39.44	2.523
		Thru 30	42.06	2.439
		Loss	0.14	—

Area		Screen (USS)	Percent Retained	Specific Gravity
Michigan Ave. East Side	(Vacuum cleaning following machine sweeping)	10	2.25%	2.577
		16	4.24	2.576
		20	2.73	2.849
		30	17.77	2.686
		Thru 30	72.71	2.497
		Loss	0.30	—

Area		Screen (USS)	Percent Retained	Specific Gravity
Michigan Ave. West Side	(Machine swept)	10	47.83%	2.450
		16	46.77	2.649
		220	0.09	2.753
		30	1.97	2.882
		Thru 30	0.62	2.476
		Loss	2.72	—

Area		Screen (USS)	Percent Retained	Specific Gravity
Michigan Ave. West Side	(Vacuum cleaning following machine sweeping)	10	4.54%	2.518
		16	13.03	2.274
		20	6.66	2.358
		30	8.93	2.435
		Thru 30	65.48	2.435
		Loss	1.35	--

2. Analysis of Dog Droppings

Three laboratory examinations were made of dog droppings found within the test sections. The results of the analysis were as follows:

Item	Sample		
	1	2	3
Water Soluble mg/100 ml	16.5	20.2	178.3
Volatile Water Soluble mg/ 100 ml	10.3	15.9	145.8
5-Day BOD mg/g	78	377.3	300
COD	200.7	552	720
Coliform Organism MPN/g	16,090	16,090	$14X10^5$

3. Sweeping Efficiency Tests

A. In order to determine effectiveness when sweeping 16 grain sand, uniformly distributed over a 300 ft² surface, comparative testing was conducted on four different types of sweepers:

  (1) 4 Wheel Model 945 (SN 677) with Mark I Milemaster Broom
  (2) 3 Wheel Model 984 (SN 320) with Mark I Milemaster Broom
  (3) Air Jet (SN 707-699)
  (4) Starsweep Model 554 (SN 999)

B. Utilizing the test course (see Figure 12), the following outline describes the procedure followed to collect the test data.

  (1) A known weight of 16 grain sand was placed in a commercial hand powered spreader.

  (2) The sand was spread on the 3 foot by 100 foot test course lapping over both ends of the course to eliminate starting or stopping inconsistencies. Figure E-1 describes the test layout.

  (3) The sand remaining in the spreader and that amount lapped over the ends of the course were swept up and weighed. The difference of that initially placed in the spreader and that remaining was entered into the data sheet as "Sand Placed."

C. A spot check on the evenness of the distribution of the sand was made by randomly selecting one 3 foot by 10 foot section, manually sweeping it clean and weighing the sand obtained. The weight of this sand was entered on the data sheet as "Spot Check" and ideally should equal 10 percent of the "Sand Placed."

D. The difference of "Sand Placed" and "Spot Check" is the "Net Sand."

E. The course was then swept using the sweeper being tested. The sweeper was stopped at a point approximately 15 feet beyond the end of the test course. The Pickup Broom and Elevator (if the sweeper had one) was left running for a short time then stopped and raised. The vehicle was then driven forward. That sand which remained on the asphalt ahead of the Pickup Broom and behind the Elevator was manually swept, weighed and recorded on the data sheet as "Residual."

F. Sand remaining on the test course and 10 feet beyond the end of the course was then swept up, weighed, and recorded on the data sheet as "Residual."

G. This procedure was conducted a minimum of three times for each set of test parameters to check for result consistency.

H. The following table summarizes, for each sweeper, the parameters tested.

Test Sweeper	Test Course Traverse Speed	Sand Concentration	Pickup Broom Diameter	Pickup Broom R.P.M.	Strike Pattern
4 Wheel S/N 677	5 MPH	.05 & .10 lbs/ft^2	Std new broom dia & 20.75" dia	110 RPM (aux eng 2200) & 130 RPM (aux eng 2600)	5", 6" & 7"
3 Wheel S/N	5 MPH & 6.4 MPH	.05 & .10 lbs/ft^2	Std new broom dia & 20.75" dia	137 RPM (5 MPH) 175 RPM (6.4 MPH)	5", 7" & 9"
Air Jet	5 MPH	.05 & .10 lbs/ft^2	Std new agitator	Aux eng 2400 RPM	1.5" agitator brm strike
Starsweep Model 554	3.5 MPH & 5 MPH	.05 & .10 lbs/ft^2	Std new broom		2.75"

I. Results appear in Tables E-1, E-2, E-3

J. The sweeping efficiencies were calculated by the equation:

$$\text{Sweeping Efficiency} = \frac{\text{Net Sand - Residual}}{\text{Net Sand}} \times 100$$

TABLE E-1

Strike	Pick-up Broom RPM	TRAVERSE SPEED (MPH)	M=Max Pub Dia m=Min Pub Dia	1st RUN			2nd RUN			3rd RUN			AVERAGE		
				NET SAND	Net Sand -Residual	Sweeping Efficiency	Net Sand	Net Sand -Residual	Sweeping Efficiency	Net Sand	Net Sand -Residual	Sweeping Efficiency	ΣNet Sand	Σ Net Sand -Residual	Avg. Sweeping Efficiency
9	175	6.4	M	22.25	21.75	97.6	28.25	27.68	48.0	31.68	31.06	98.1	82.18	80.49	97.9
9	175	6.4	M	12.62	12.31	97.6	15.56	15.31	98.5	15.31	14.88	97.0	43.49	42.50	97.8
9	137	5.0	M	27.75	27.25	98.3	30.25	29.68	98.1	27.50	26.94	98.0	85.50	83.87	98.1
9	137	5.0	M	11.56	11.31	98.0	12.25	11.88	96.9	14.38	14.12	98.4	38.19	37.31	97.7
7	175	6.4	M	31.38	30.88	98.5	31.25	30.81	98.6	27.50	27.12	98.6	90.13	88.81	98.5
7	175	6.4	M	15.19	14.44	95.3	15.25	14.94	98.0	15.25	14.75	96.7	45.69	44.13	96.6
7	137	5.0	M	32.19	31.31	97.3	27.31	26.62	97.6	28.56	27.62	96.9	88.06	85.55	97.1
7	137	5.0	M	16.19	15.56	96.1	14.94	14.38	96.2	15.68	15.12	96.6	46.81	45.06	96.4
5	175	6.4	M	24.31	22.44	92.5	27.50	25.88	94.1	25.88	23.88	92.4	77.69	72.20	92.9
5	175	6.4	M	15.44	13.88	89.8	18.19	16.25	89.5	15.44	14.25	92.2	49.07	44.38	90.4
5	175	6.4	M	27.00	24.75	91.6	28.12	26.94	95.9	27.25	22.88	84.0			
5	175	6.4	M	28.81	26.50	91.9	27.94	23.19	83.0				139.12	124.26	89.4
5	175	6.4	M	16.19	13.38	82.6	15.25	14.12	92.6	15.31	13.56	88.5			
5	175	6.4	M	14.88	12.44	83.8	16.50	12.81	77.7				78.13	66.31	84.7
5	137	5.0	M	25.62	23.44	91.5	26.25	24.12	91.8	26.25	25.38	96.5	78.12	72.94	93.3
5	137	5.0	M	13.88	12.68	91.4	14.44	13.50	93.5	14.75	13.75	93.2	43.07	39.93	92.6
5	137	5.0	M	29.25	28.50	97.4	27.19	26.06	95.9	29.56	28.62	97.0			
5	137	5.0	M	27.88	24.06	86.2	26.68	22.50	84.3				140.96	129.74	92.3
5	137	5.0	M	16.94	14.56	85.9	16.25	14.94	92.0	15.94	14.68	92.0			
5	137	5.0	M	16.00	12.62	79.0	14.00	11.88	84.8				79.13	68.68	86.7
5	175	6.4	m	28.19	26.00	92.4	25.25	22.25	88.2	26.00	21.25	81.8	79.44	69.50	87.6
5	175	6.4	m	13.50	12.44	92.2	14.81	14.38	96.9	16.44	15.50	94.3	44.75	42.32	94.5
5	137	5.0	m	31.56	30.75	97.5	33.94	33.00	97.3	23.44	22.68	96.7	88.94	86.43	97.1
5	137	5.0	m	17.25	16.75	97.1	12.00	11.56	96.4	12.12	11.56	95.2	41.37	39.87	96.5

3 Wheel Model No. 984
Mark 1 Milemaster

* Erratic Data Felt due to Malfunction of Pickup Broom Suspension Chain.

TABLE E-2

Strike	Pick-up Broom RPM	M=Max Pub Dia m=Min Pub Dia	1st RUN			2nd RUN			3rd RUN			AVERAGE		
			Net Sand	Net Sand -Residual	Sweeping Efficiency	Net Sand	Net Sand -Residual	Sweeping Efficiency	Net Sand	Net Sand -Residual	Sweeping Efficiency	Net Sand -Residual	Σ Net Sand - ΣResidual	Avg. Sweeping Efficiency
7	110	M	26.88	26.25	97.7	28.62	28.00	97.7	27.06	26.56	98.0	82.56	80.81	97.8
7	110	M	13.75	13.31	96.9	12.88	12.47	96.9	11.56	11.09	95.9	33.19	36.87	96.7
6	110	m	31.06	29.56	95.0	29.56	27.68	93.8	32.50	31.25	96.3	93.12	83.49	94.9
6	110	m	11.38	10.56	92.9	15.44	14.00	90.6	13.75	12.75	92.7	40.57	37.31	91.8
7	130	M	25.56	25.06	98.2	25.88	25.50	98.5	27.44	27.00	98.3	78.88	77.56	98.4
7	130	M	13.19	12.81	97.4	14.50	14.12	97.4	15.56	15.00	96.5	43.25	41.93	96.9
6	130	m	16.44	15.31	93.2	12.31	11.50	93.2	12.44	11.66	93.6	41.19	38.47	93.4
6	130	m	34.81	33.25	95.5	23.63	22.25	94.1	23.00	21.94	95.4	81.49	77.44	95.0
5	110	M	28.00	25.12	89.8	28.06	26.00	92.7	25.62	23.62	92.2	31.68	74.74	91.6
5	110	M	14.44	13.50	93.4	14.44	13.50	93.4	14.31	13.25	92.5	43.19	40.25	93.2
5	110	m	31.50	25.31	80.4	24.38	19.75	81.1	23.44	20.06	85.5	79.32	65.12	82.1
5	110	m	13.31	10.56	79.2	18.38	16.38	89.1	13.50	12.25	90.8	45.19	39.19	86.6
5	130	M	14.25	13.56	95.1	14.38	13.62	94.9	12.94	12.12	93.7	41.57	39.30	94.5
5	130	M	26.19	25.19	96.2	26.81	26.06	97.1	26.85	25.81	96.1	79.88	77.06	96.5
5	130	m	25.94	21.88	84.4	27.31	23.25	85.2	28.12	23.81	84.8	81.37	68.94	84.8
5	130	m	16.38	15.25	93.1	13.75	12.63	92.1	13.31	11.84	89.0	43.44	39.77	91.7

4 Wheel Model No. 945

Mark I Milemaster, Traverse Speed 5 MPH

TABLE E-3

Traverse Speed (MPH)	1st RUN			2nd Run			3rd RUN			AVERAGE		
	Net Sand	Net Sand -Residual	Sweeping Efficiency	Net Sand	Net Sand -Residual	Sweeping Efficiency	Net Sand	Net Sand -Residual	Sweeping Efficiency	Σ Net Sand	Σ Net Sand - Σ Residual	Avg. Sweeping Efficiency
3.5	27.94	27.68	99.1	25.25	25.00	98.9	25.81	25.44	98.6	79.00	72.12	98.9
3.5	16.62	16.50	99.2	14.94	14.68	98.2	13.88	13.68	98.5	45.44	44.86	98.9
5.0	26.68	26.31	98.5	25.25	24.81	98.3	26.38	25.94	98.4	78.31	77.06	98.4
5.0	15.00	14.62	97.5	15.00	14.62	97.5	12.94	12.56	97.0	42.94	41.80	97.3

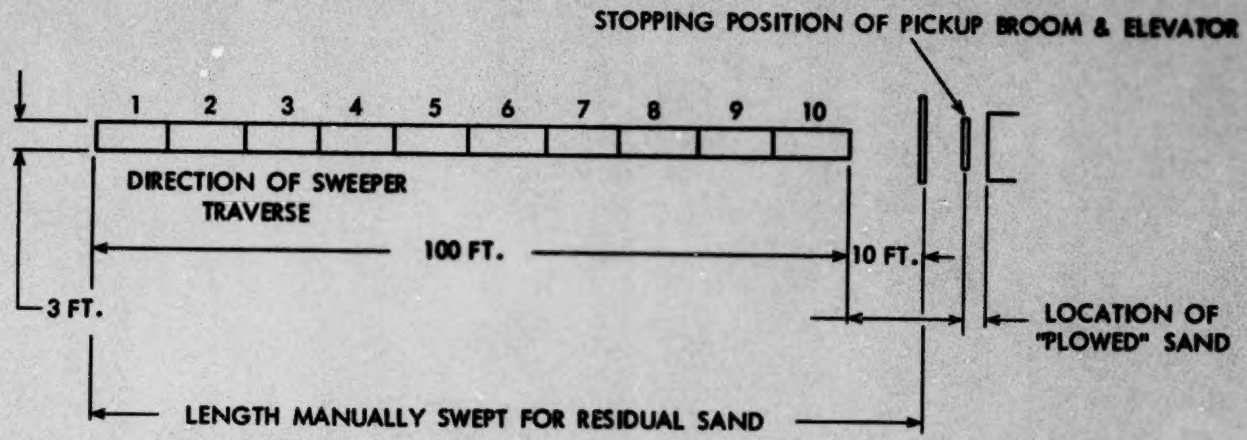
Starsweep Model No. 554

New Broom In All Tests, Strike Pattern = 2.75

1st RUN			2nd RUN			3rd RUN			AVERAGE		
Net Sand	Net Sand -Residual	Sweeping Efficiency	Net Sand	Net Sand -Residual	Sweeping Efficiency	Net Sand	Net Sand -Residual	Sweeping Efficiency	Σ Net Sand	Σ-Residual Σ	Avg. Sweeping Efficiency
25.25	24.69	97.8	22.31	22.00	98.7	22.31	22.25	99.8			
29.94	29.88	99.8							99.81	98.82	99.1
18.88	18.81	99.7	16.44	16.41	99.9	17.44	17.41	99.9	52.76	52.63	99.8

Air Jet Model No. 770

Agitator Strike 1.5 In., Auxiliary Engine Speed 2400 RPM


STOPPING POSITION OF PICKUP BROOM & ELEVATOR
1
2
3
4
5
6
7
8
9
10
DIRECTION OF SWEEPER TRAVERSE
100 FT.
10 FT.
3 FT.
LOCATION OF "PLOWED" SAND
LENGTH MANUALLY SWEPT FOR RESIDUAL SAND

TEST COURSE SURFACE: COMMON MUNICIPAL QUALITY FLAT ASPHALT PAYING

FIGURE 12 SWEEPING EFFICIENCY TEST COURSE

Appendix F

Abstract of Ordinances Designed to Reduce The Pollution Potential of Urban Wastes

Grouped within the eighteen categories which follow are pertinent provisions of actual and model ordinances which have been assembled and analyzed in the course of this study.

The actual ordinances have been received from city officials—customarily the city clerk—of some 120 cities of various size and location, each of which is identified in the references thereto. The excerpts presented here were selected as typical of provisions likely to be effective or, in a few cases, as novel or exceptional in their approach. By inference these may be deemed worthy of emulation but they are not designed or submitted as "model" ordinances. They are simply ordinances which have been enacted and are in force in the particular city—upon which another jurisdiction might "pattern" an enactment, but only after careful consideration of its distinctive legal and operational situation.

In a number of the sections there *are* references to truly "model" ordinances, carefully designed and authoritatively published by the National Institute of Municipal Law Officers, 839 17th Street, N.W., Washington, D.C. This organization, preeminent in the field of municipal law, is customarily and herein designated by its initials as NIMLO. All excerpted provisions herein are from the organization's copyright "NIMLO Model Ordinance Service" and used by its permission. Each is specifically identified as of NIMLO origin. The reference may identify the model ordinance by its individual title—or, when only "the NIMLO model" is stated, it accords with the section heading just preceding. No so-called "model ordinance" provisions from any other source appear herein.

Anti-Litter Ordinances

Within the past ten or so years the American public has become very conscious of "litter" as a despoiler of natural scenic beauty, as a slovenly method utilized by many thoughtless people for "disposal" of their rapidly growing share of the waste materials (mainly of paper or plastic in the form of product containers or wrappings) of current civilization, and as a mounting bill of expense for public cleanup and sanitation services.

So intense has been the concern with the litter problem that a compulsion toward attacking it via comprehensive and all-encompassing "anti-litter" laws and ordinances has become apparent. The objective has been considerably advanced by the development and publication of a "Model Anti-Litter Ordinance" by the National Institute of Municipal Law Officers. In its introduction to the document the organization recounts that:

> "Traditionally, sections pertaining to litter, in its many forms, are scattered throughout the typical municipal code. The problem is so vast, and the sources of litter so varied, that litter necessarily has been dealt with at many different points in municipal codes. The NIMLO Model . . . attempts to extract from comprehensive, basic codes and collect in one place all those regulatory provisions having particular reference to the litter problem *as the public thinks of it today*.
>
> "Careful study and analysis of scores of municipal codes . . . clearly indicated that a model ordinance going to the heart of the modern litter problem must concern itself with the origins, kinds and gathering places of litter . . .
>
> "The broad, generic term 'litter' has been selected for definition and use throughout the model ordinance because it is the labeling phrase around which public awareness and action have been rallied. 'Litter,' now more than any other word or collection of words, best identifies the problem as the public understands it. Moreover, from the standpoint of draftsmanship, the old and cumbersome practice of listing the infinite sources of litter is ineffective and unwieldy. At best, the lengthiest, comma-separated collection of likely contributors to the litter problem will be incomplete, and the public is very often led to believe that the ordinance strikes only at the kinds of litter listed."

The definition in *Sec. 8-2402 (6)* of the NIMLO model asserts that: " 'Litter' is 'garbage,' 'refuse,' and 'rubbish' as defined herein and all other waste material which, if thrown or deposited as herein prohibited, tends to create a danger to public health, safety and welfare."—and the annotation indicates that, as respects the three "constituent" items, "classifications of the American Public Works Association are adopted for the definitions of those terms."

Overall the NIMLO model contains twenty substantive sections (in addition to its "short title," penalty, separability and repealer sections). The "model" has been adopted wholly or substantially *in toto* by many cities; among the larger ones are Cleveland, Dallas and Toledo—the list also including Lincoln, Nebraska, Albuquerque, New Mexico, Fairbanks, Alaska, Oak Ridge, Tennessee, Des Moines, Iowa, and Newport News, Virginia.

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In this comprehensive exploration of ordinances relevant to possibilities of stream pollution via access of surface waters we have considered the subject matter of many of the sections of the NIMLO model, or any other comprehensive "anti-litter" enactment, elsewhere in the study and separately in direct relation to the particular subjects. This has been the case in relation to such matters as handbills, spillage from trucks, cleanliness of occupied and unoccupied private property, sweeping onto sidewalks, etc.

There remain, within the overall "anti-litter" ordinance framework, a few aspects covered wholly adequately, and briefly, by the appropriate NIMLO section, and a few others where individual-city provisions may be helpfully adduced in addition to the model language.

Aircraft and Vehicles, Lakes and Fountains, Posting of Notices

The above-captioned headings clue subjects on which recitation of NIMLO's language, of characteristic brevity, should be fully sufficient for present purposes; to wit:

> "No person in an aircraft shall throw out, drop or deposit within the City any litter, handbill or any other object." *Sec. 8-2416*
>
> "No person, while a driver or passenger in a vehicle, shall throw or deposit litter upon any street or other public place within the City, or upon private property." *Sec. 8-2407*
>
> "No person shall throw or deposit litter in any fountain, pond, lake, stream, bay or any other body of water in a park or elsewhere within the City." *Sec. 8-2410*
>
> "No person shall post or affix any notice, poster or other paper or device, calculated to attract the attention of the public, to any lamp post, public utility pole or shade tree, or upon any public structure or building, except as may be authorized or required by law." *Sec. 8-2417*

Litter in Public Parks

With the observation that "Parks, too, are public places" and are therefore covered within the basic section, the annotations to the NIMLO model assert that "However, because so much of the litter problem is concerned with the pollution of otherwise restful and beautiful areas set aside for public recreation it is felt, . . . that park litter should be stressed in a separate section." Accordingly the separate section appears as follows:

> "No person shall throw or deposit litter in any park within the City except in public receptacles and in such a manner that the litter will be prevented from being carried or deposited by the elements upon any part of the park or upon any street or other public place. Where public receptacles are not provided, all such litter shall be carried away from the park by the person responsible for its presence and properly disposed of elsewhere as provided herein." *Sec. 8-2409*

As typical of more detailed litter-related and pollution-related matters covered in overall "Park Rules and Regulations" Honolulu includes the following items among those banned, or authorized only by permit, respectively:

> "Within the limits of any public park, it shall be unlawful for any person to: . . . (3) Swim, bathe, wade in, or pollute the water of any ornamental pool or fountain. (4) Throw or dispose of any refuse or waste material, except in receptacles placed therein. . . . (7) Distribute, post or place any commercial handbills or circulars, notices, or other advertising devices or matter, except as permitted by the terms of any agreement relating to the use of park property. . . . (9) Construct or fabricate surfboards. (10) Permit any dog to enter and remain within the confines of any park area where signs prohibiting dogs are posted. . . ." *Code, Sec. 13-18.2. a*
>
> "Except as authorized by permits of, and subject to the terms and conditions imposed by, the Department of Parks and Recreation, it shall be unlawful for any person, within the limits of any public park, to: (1) Lead or let loose any cattle, horse, mule, goat, sheep, swine or fowl of any kind. . . . (4) Camp or erect or maintain a tent or camping facilities. (5) Sell or offer for sale any merchandise, article or thing, whatsoever. . . . (7) Repair or condition any surfboard. (8) Ride or drive any horse or other animal." *Code, Sec. 13-18.2 b*

With further reference to surfboards, mentioned in both the above excerpts, Honolulu further provides that:

> "In addition to the requirements . . . above, the repair or conditioning of any surfboard shall be performed only by a concessionaire . . . who has a surfboard concession. Such repair work shall be conducted only in an enclosed building or structure, approved by the Department of Parks and Recreation and the State Department of Health. The terms and conditions to be imposed . . . shall include, together with the requirements necessary to safeguard the health and safety of the public, the securing of adequate insurance to protect the City from any liability resulting from such repair work." *Code, Sec. 13-18.2.d*

Public Litter Receptacles

The care and "feeding" of public litter receptacles, and their placement and protection, constitutes a substantially new element of the "anti-litter" ordinance not usually found in prior provisions of earlier codes. The NIMLO model specifies that:

> "Persons placing litter in public receptacles or in authorized private receptacles shall do so in such a manner as to prevent it from being carried or deposited by the elements upon any street, sidewalk or other public place or upon private property." *Sec. 8-2404*

Cities have often found additional necessities for authorizing or installing such receptacles, to regulate their use and to protect them from vandalism and theft. Such are the objectives of such ordinances as the following of Miami, San Antonio and Rockville, Maryland, respectively:

> "The City will provide . . . trash containers to be placed in strategic locations throughout the City . . . with special consideration to be given to high density population and trafficked areas, which shall be used for pedestrians only and not by abutting store owners or vendors." *Ord. No. 7302 of 5/5/65, Sec. 2*

> "It shall be lawful, with the consent of the city, to place public trash receptacles upon the streets, plazas and parks of the city at such points as not to obstruct traffic on any street, for the reception of such trash. It shall be unlawful for any person to tamper with, injure or deface any public receptacles for trash in the city." *Code, Secs. 17-14 and 17-15*

> "It shall be unlawful for any person or persons to take and carry away, or willfully break, injure or destroy any box or other receptacle maintained upon any street or alley . . . for the reception of paper, filth or waste matter." *Code, Sec. 12-1.10*

Forbidding *misuse* of this equipment often demands legislative attention. Publicly provided litter receptacles—placed on the sidewalks and elsewhere for public convenience—are not, of course, intended as depositories for garbage or other than casual refuse. This point is made in ordinances of Westport, Connecticut, Council Bluffs, Iowa, and Seattle, Washington, in terms respectively as follows:

> "The deposit of garbage or any other organic matter in the rubbish containers provided by the Town . . . is hereby prohibited." *5/1/29 Ordinance Amended 3/17/52, Sec. 2*

> "When the city shall have . . . provided for the placing of wastepaper boxes or receptacles along and upon the sidewalks . . . wastepaper, cloth, rags or any like light combustible matter may be placed in such receptacle . . . but it shall be unlawful to deposit in said boxes any sweepings, ashes, garbage, manure, earth or other refuse . . ." *Code, Sec. 8.50.020*

> "It shall be unlawful to place litter accumulated on private property, or burning or smoldering materials, or dead animals, in any receptacle provided by the City for litter disposal . . ." *Ord. No. 89021 of 2/24/60, Sec. 3*

Debris, etc. on Vacant Lots

The problems stemming from the growth of deleterious vegetation or the accumulation of litter and refuse on vacant lots have been attacked by cities in a variety of ways. Protection of such uninhabited spaces from "dump and run" drivers is the objective of such legislation as the Prichard, Alabama, ordinance which decrees that:

> "No person shall throw . . . upon any vacant lot or lots, . . . or upon any other ground . . . any old lumber, trash, combustible material . . . or garbage under such penalty as the Court may prescribe . . ." *Code, Sec. 88 (42) (2)*

A brief provision in Dallas, Texas, asserts simply that:

> "No person shall throw or deposit litter on any open or vacant property within the City whether owned by such person or not." *Code, Sec. 7A-19*

In San Francisco it is made the owner's responsibility to remove rubbish after notice:

> "Owners of all vacant lots . . . are hereby required to remove all rubbish and debris thereon within thirty (30) days after the receipt of notice to remove the same. Notice to remove such rubbish and debris shall be given by the Police Department and served by delivering a copy thereof to the owner or his agent personally, or if such owner or agent be not known, then by posting the same in a conspicuous place on the lot to be described in the notice." *Police Code, Sec. 79.*

Hawaii County, Hawaii, requires owners in Hilo to clear underbrush from their vacant lots, while Daytona Beach, Florida, declares that the city will not collect such cleared material. Pertinent excerpts from their respective ordinances follow:

> "Every owner of any unoccupied lot the frontage of which abuts or adjoins any public street or highway within the City of Hilo, shall clear such lot of all refuse and uncultivated undergrowth thereon to a depth of not exceeding 100 feet from any street or highway adjoining, whenever on

> such lot there is refuse or uncultivated undergrowth to such an extent that such lot has become or is likely to become a fire, health or crime hazard." *Ordinance No. 33, Sec. 1*

> "No collection of material from the clearing of lots shall be assumed by the city. This shall be the responsibility of the owner or contractor . . ." *Code, Sec. 17-16*

Enforcement for the clearance of litter from vacant lots is typified in the ordinance of Newport News, Virginia, from which the following excerpted provisions are taken:

> "The Health Officer . . . is hereby authorized . . . to notify the owner of any open or vacant private property . . . to properly dispose of litter . . . on such . . . property which is dangerous to public health, safety or welfare. . . . Upon the failure, neglect or refusal . . . to properly dispose of litter . . . within ten (10) days . . . the Health Officer is hereby authorized and empowered to order its disposal by the City. When the City has effected the removal . . . the actual cost thereof, plus . . . interest at . . . six percent . . . shall be charged to the owner . . . on the next regular tax bill . . . Where the full amount due the City is not paid . . . within ten (10) days after the disposal of such litter, . . . the Health Officer shall cause to be recorded . . . a sworn statement showing the cost and expense incurred . . . which . . . shall constitute a lien . . . and shall remain in full force . . . until final payment has been made. . . ." *Ordinance No. 178, Sec. 19*

Presumably Vacant Lands

Several ordinances of apparently primary applicability to vacant lots, though not specifically so restricted, are worthy of notice in relation to this subject matter. One such is an enactment of Morris Township, New Jersey, stipulating that:

> "It shall be unlawful for any owner or possessor of land in this Township to do any of the following: (a) Permit such land to be covered with or contain brush, weeds, dead and dying trees, stumps, roots, obnoxious growths, filth, garbage, manure, trash, refuse or debris or any combination of said items, which would either tend to start a fire, increase the intensity of a fire already started, . . . cause poisoning or irritation to human beings from the obnoxious growths or cause or tend to cause an unhealthy or obnoxious condition . . . (b) Permit such land to be covered with or contain refuse or debris resulting from the construction, demolition or neglect of a building, . . . where such refuse or debris is inimical to the preservation of the public health, safety or general welfare . . . (c) Permit on such land an abandoned, unused or unprotected well, cellar or other unnatural declivity in which stagnant water or debris is retained . . . (d) Permit to be stored or placed on such land . . . junk, paper, clothes, glass or refuse or any combination of them, which is either a fire hazard, retains stagnant water, emits foul or obnoxious odors, or which is dangerous to a person, including a child, being or coming upon said land. . . ." *Ord. No. 6-64 of 5/14/64. Sec. 1*

New Orleans in 1948 enacted an ordinance which is well outlined in the *title* of same, as follows:

> ". . . providing for the cuttting, destroying and removal of weeds or grass, or deleterious, unhealthful growths, or other noxious matter, growing, lying or located in or upon any lot, place, area, or sidewalk abutting same, within the City of New Orleans; authorizing the Commissioner of Public Property . . . to cut, destroy and remove the same upon failure of the owner, or agent . . . to do so after written notice, and charge the cost thereof, together with six percent (6%) accrued interest on the next regular bill of said owner; providing for the payment of ten percent (10%) delinquent interest; providing that such charge and interest, after recordation . . . shall constitute a lien . . . on said property in favor of the City . . ." *Ord. No. 17,329 of 6/25/48*

Little Rock, Arkansas, by ordinance (with emphasis supplied) empowers:

> "the head of the city department of sanitation, in his discretion, . . . to order . . . the owner of *any lot or lots or other real property* within the city to cut weeds, remove garbage, rubbish and other unsightly and unsanitary articles and things . . . and to eliminate, fill up, or remove stagnant pools of water or any other unsanitary . . . condition . . ." *Code, Sec. 15-18*

As to Vacant or Occupied Property

Two ordinances obviously aimed at vacant lots but specifically made applicable (per emphasis supplied) to occupied property as well are those of Louisville, Kentucky, and New Rochelle, New York, which follow:

"It shall be unlawful for the owner, agent or occupant of *a lot whereon a building of any kind may exist*, or the owner or agent in charge of any vacant lot . . . to permit any growth of weeds, . . . or collection of garbage or filth . . . to remain on the lot . . . longer . . . than three days after notice to remove same . . ." *Code, Sec. 1101.03*

> "No person shall throw . . . ashes, offal, garbage, dross, . . . or rubbish . . . upon any vacant lot or public place nor shall the owner of any vacant lot *or parcel of land upon which any building or improvements may stand* permit or suffer to remain upon his property . . . any accumulation whatsoever of ashes, offal, garbage, dross, . . . or rubbish . . ." *Code, Sec. 7-1.c.1*

Stagnant Water

In some of the ordinances already cited "stagnant water" appears in the itemization of objectionable conditions to be corrected; this is true also in the ordinance excerpts (emphasis supplied) of Stroudsburg, Pennsylvania, and Jonesboro, Arkansas, which follow:

> "It is hereby declared unlawful to maintain . . . any nuisance, . . . specifically including . . . accumulations of garbage or other refuse material, *accumulations of waste or stagnant waters, etc.*" *Ord. No. 278 of 5/5/44, Sec. 1*

> "It shall hereafter be unlawful . . . to neglect or refuse . . . to remove garbage, rubbish and other unsightly and unsanitary articles and things from . . . lots and real property *or to eliminate, fill up or remove stagnant pools of water* or other unsanitary . . . conditions . . ." *Ordinance No. 717, Sec. 1*

Ordinances specifically in relation to stagnant water are those which follow—of Portland, Oregon (the section in its entirety), and of Nebraska City, Nebraska.

(principal sections briefed), respectively:

> "It shall be unlawful for any person to permit or suffer water to flow onto or be cast upon any yard, lot, block, place or premises or into or upon any street, gutter, or place adjacent to or abutting upon any yard, lot, block, or premises so that the same may become stagnant or impure and cause an offensive smell. It shall also be unlawful for any person to permit or suffer to accumulate any stagnant, impure, or odorous water in or upon any yard, lot, block, place, or premises, or upon any street or street gutter adjacent to or adjoining any yard, lot, block, place, or premises owned or occupied by him, or for which he may be agent." *Health and Sanitation Code, Sec. 18-1706*

> "The permitting or maintaining of . . . stagnant water on any lot or piece of ground . . . is hereby prohibited, and every owner or occupant . . . is hereby required . . . to drain or fill up said lot or piece of ground . . . so as to prevent stagnant water . . . accumulating thereon . . . It shall be the duty of the owners . . . to drain or fill or otherwise dispose of any of the stagnant water . . . within ten (10) days from the time that they are notified . . . by resolution passed by the City Council and served upon the owners . . . In case that such owners . . . fail to remove . . . the stagnant water . . . it shall be the duty of the Superintendent of the Department of Streets, Public Improvements and Public Property . . . to drain or fill such lots . . . or pieces of ground so as to remove all stagnant water . . . upon being authorized so to do by a resolution of the Council. The resolution authorizing the Superintendent . . . to so drain or fill such lots . . . shall designate and describe . . . the kind and quality and the estimated amount of work to be done . . . It shall be the duty of the Superintendent . . . within ten (10) days . . . to drain and fill such lots . . . as provided for in the resolution . . . The cost . . . shall be assessed against the . . . lots and pieces of ground, and shall be a special assessment . . . collected as other taxes. The costs . . . shall be levied and assessed by the Council . . . and such taxes or assessments . . . shall become delinquent within fifty (50) days . . . and . . . bear interest at the same rate . . . as other delinquent taxes and shall be a lien upon the property . . ." *Ord. No. 908 of 8/6/51, Secs. 1-7*

Parking Lots and Garages

Pertinent regulations of off-street parking facilities basically relate to surface cleanliness and/or the accumulation of litter and refuse. The NIMLO model stresses the former is requiring that:

> "The ground or floor space of each parking lot or garage, if made of dirt, sand, cinders or other loose mixture, shall at all times be kept thoroughly sprinkled or treated with water, calcium or other means, so that the dust, sand, cinders, or other substance of which said ground or floor space is made will not be raised, carried or blown by the wind, movement of vehicles, or other causes, into or upon public property, or the adjacent property of others. . . ." *Sec. 5-517 (b)*

Denver, Colorado, incorporates in its parking lot regulations substantially the same provisions, except that the surface shall be treated:

> ". . . with oil or some other suitable mixture, substance, material, or preparation . . ." *Ord. No. 45 of 5/29/46, Sec. 8*

Regulations respectively more stringent and less stringent are provided in the governing ordinances of Newark, New Jersey, and Bettendorf, Iowa, as follows:

> "Parking lots shall be paved with a smooth, hard surface which shall be maintained in good and safe condition. . . ." *Code, Sec. 8.263 (3;*

> "Ground surfaces . . . paved or adequately treated to keep dust, dirt and mud at a minimum." *Ord. No. 296 of 7/1/52, Sec. 4 (d)*

About midway between the foregoing is the stipulation by Bedford Park, Illinois, that:

> "In order to minimize atmospheric pollution and to reduce the amount of dirt, mud, debris or other substances, whether liquid or solid, from being deposited upon the streets and public ways in the Village, it shall be unlawful . . . to maintain, keep or conduct . . . any parking lot . . . unless the entire surface thereof is graded and is covered with either blacktopping or concrete. . . ." *Code, Sec. 5-14-2*

Des Moines, Iowa, goes into considerably greater detail—and with a broadened scope that also includes lots". . . which are used or to be used for the sale of motor vehicles by a dealer in such vehicles . . ."—in providing that:

> "It shall be unlawful for any person to operate . . . any outdoor motor vehicle parking space unless the surface . . . shall first have been covered with concrete to a depth of at least six inches, or with plant-mixed asphalt to a depth of at least two inches laid upon stone bracing of not less than three inches in depth, or unless the surface shall be covered with a quantity of road oil, calcium chloride or other dust-preventive substance sufficient to prevent the accumulation and blowing of dust or dirt upon or from the surface."—and further requiring that the operator must:
>
> ". . . renew the dust-preventive covering on the surface of such space as often as shall be necessary to prevent the accumulation and blowing of dust upon and from such surface. In spaces on which road oil is used, this shall be construed to require thorough covering of the surface with such oil at least once every four months." *Code, Sec. 33-2*

Provisions which Boise, Idaho, specifically aims at "littering public parking facilities" exclude automobile sales lots but do include the grounds of drive-in restaurants and mercantile free parking space. The pertinent four Code sections, recently enacted, follow in their entirety:

> 6-13-1: *Definitions:* For the purpose of this Chapter "public parking facility" is defined as any place or grounds where the parking of motor vehicles in connection with grocery or other stores, or premises or grounds maintained in connection with businesses commonly known as 'Drive-ins' where food, beverages or refreshments are served to patrons in motor vehicles, or at tables or stands in open area, for consumption either in or off the premises.
>
> 6-13-2: *Install No-Litter Sign:* Persons owning, operating, managing or conducting a public parking facility shall place in conspicuous places at said facility, signs on which are written in legible English, in letters at least two inches in height on contrasting background, words or phrases requesting patrons to refrain from throwing of any waste material upon the parking area, sidewalk, street, roadway, or gutter, or adjoining property.
>
> 6-13-3: *Littering Public Ways Prohibited:* No person shall place, throw or deposit any waste material upon the outside premises or parking area of a public parking facility or on any street or alley adjoining such public parking facility, except in adequate receptacles provided for that purpose.
>
> 6-13-4: *Obligation of Operator:* The owner or his agent or operator shall keep the premises whereon the public parking facility is located, together with the parking area and that portion of any street or alley adjoining such facility free from waste material. The owner or his agent or operator shall provide the public parking facility with a sufficient number of adequate refuse containers. *Code, Art. 6, Chap. 13*

Relating *solely to* used car lots, a recent licensing ordinance of Wauwatosa, Wisconsin, provides that "All premises whereon is conducted the business herein licensed shall be paved with a hard surface" and requires the license application to include "a statement of the type of surface with which the lot . . . is paved" and stipulated that:

> "The Board of Public Works shall approve the surfacing of all used car lots so as to insure adequate and proper drainage; . . ." *Code, Sec. 6.10 (9)*

"Drive-in" Establishments

In addition to the foregoing, establishments inviting auto-borne patronage of a more transient nature may also be sources of litter and other potential surface pollutants.

Drive-in Theatres

The NIMLO model takes account of both refuse and dust problems in providing that:

> "No person shall place, throw or deposit any food, beverage, paper, bottle or other waste materials upon the premises of any drive-in theater, nor shall the licensee permit such conduct" and that "All drives and areas used by vehicles must be satisfactorily paved by the licensee or treated to avoid creating dust." *Sec. 6-510(B), (11) and (2)*

As to the latter the Rockville, Maryland, requirement is similar, i.e.:

> "The parking and driving areas shall be so treated as to prevent the creating of dust, either by chemical treatment or hard surfacing." *Code, Sec. 13-1.06(1) (8)*

Drive-in Restaurants

In drive-in eating establishments, customers' refuse is of much more serious concern than surface construction. The NIMLO model disposes of the latter by requiring that:

> "The parking area on the premises of a drive-in restaurant shall be satisfactorily paved or treated by the licensee so as to avoid creating dust and so as to provide for adequate drainage of surface water." *Sec. 8-2318*

The sections, however, are devoted to the refuse problem—aimed at the patron and the operator, respectively:

> "No person shall place, throw or deposit any waste material upon the outside premises or parking area of a drive-in restaurant or on any street, alley or adjoining property or in the vicinity of a drive-in restaurant, except in adequate receptacles provided for that purpose, nor shall the licensee permit such conduct." *Sec. 8-2311*
>
> The licensee shall at least once in 24 hours dispose of waste materials which tend to create a public nuisance on the premises. The licensee shall keep the premises whereon the drive-in restaurant is located, together with the parking area and that portion of any street or alley adjoining the drive-in restaurant free from waste material. The licensee shall provide the drive-in restaurant with a sufficient number of adequate refuse containers. Any incinerator which may be installed shall conform with the rules and regulations of the Bureau of Smoke Abatement of the Department of Buildings and Safety Engineering (substitute appropriate title)." *Sec. 8-2312*

In its ordinance on "Drive-in Take-out Restaurants" Lakewood, California, departs from the above to relieve the licensee of the responsibility to police his customers or clean adjacent street or alley space, and to allow 48 hours for waste disposal, its pertinent sections providing that:

> No person shall place, throw or deposit any garbage, refuse or waste material upon, in or outside of the said premises, except in waste or refuse receptacles provided therefor on said premises. *Code, Sec. 6410(e-3)*, par. 7(b)
>
> The permittee shall, at least once in every forty-eight hours, dispose of waste materials or refuse deposited or accumulating on the premises of the permittee. The permittee shall provide and maintain on said premises a sufficient number of adequate waste receptacles, not less than 2 in number, for the use of consumers and said permittee. Waste or refuse as used herein includes paper cups, paper plates, straws, napkins, food, beverage, drink, frozen dessert, garbage, and all other waste material intended for disposal and which, if not placed in a proper receptacle therefor, tends to create a public nuisance by rendering said property unclean, unsafe, and unsightly. *Code, Sec. 7410(e-3), par. 4*

Trailer or Tourist Courts

Surface cleanliness of "camps" or "courts" established for the accommodation of "house trailers" or "mobile homes" usually receives only cursory attention within the comprehensive enactments which customarily provide for the regulation and licensing of such establishments. The NIMLO model on "Automobile Trailer and Tourist Camps" covers disposal of solid wastes by providing, in *Sec. 8-910(d)*, that "Every unit shall be provided with a substantial fly tight metal garbage depository from which the contents shall be removed by the city garbage collection service"—and general sanitation by stating that:

> "It is hereby made the duty of the attendant or person in charge, together with the licensee, to: . . . (2) Maintain the camp in a clean, orderly and sanitary condition at all times." *Sec. 8-912(b)*

The state "Trailer Coach Park" law of Michigan (emphasis supplied) stipulates, as to roadways, that "All streets and driveways in every trailer coach park shall be maintained in a passable and *reasonably dustproof* condition at all times," *(Sec. 75)* and takes account of the presence of animals in its provisions that "No animal washing, car washing or other slop creating practices shall be carried on in any trailer coach park, in any building, structure, or any place within the trailer coach park not designated and approved for such purposes" *(Sec. 74)* and "No domestic animals or house pets shall be allowed to run at large *or commit any nuisances* within the limits of the trailer coach park" *(Sec. 78)* — and likewise provides that:

> "Every trailer coach park shall be in charge of a responsible attendant or caretaker at all times, who shall maintain the park, its facilities and equipment in a clean, sanitary condition . . ." *Act No. 243 of 1959, as amended (10/65 edition), Sec. 77*

Seattle, Washington, employs a variant, in its requirement that:

> "Mobile Home Parks shall be maintained in a safe and sanitary condition, free from rodents, vermin, trash and litter." *Ord. No. 89715 of 11/2/60, Sec. 5.010*

In Ketchikan, Alaska, some responsibility is placed upon trailer occupants by the assertion that:

> "It shall be unlawful for any person occupying or using any automobile trailer as a place of human habitation to drain therefrom or permit to be drained therefrom and on to the ground any

> waste water, sewage, or other liquids or to deposit upon the ground any garbage, trash, drainage, or filth therefrom." *Code, Sec. 5-32*

This approach is amplified in the ordinance of Nebraska City, Nebraska, which provides that:

> "There shall be provided by the operator of every trailer home court, a tight receptacle with close fitting metal cover for garbage, refuse, rubbish, and ashes, for each unit space, and such receptacles shall at all times be maintained in a clean and sanitary manner. It shall be unlawful for any person to deposit any garbage, refuse, rubbish, or ashes, or any other waste matter in any place within any trailer home court except in a receptacle provided therefor." *Ord. No. 1084, Sec. 15*

Specifics for the disposal of solid wastes in trailer courts are set forth by Nashville and Davidson Counties, Tennessee, in a comprehensive section providing that:

> "The storage, collection and disposal of refuse in the court shall be so managed as to create no health hazards, rodent harborage, insect-breeding areas, accident hazards, or air pollution. All refuse shall be stored in fly-tight, water-tight, rodentproof containers, which shall be provided in sufficient number and capacity to prevent any refuse from overflowing. Satisfactory container racks or holders shall be provided, and shall be located not more than 150 feet from any trailer-coach space. Garbage shall be collected and disposed of in an approved manner, at least twice per week. *Public Health Code, Chap. 8, Sec. 3.809*

The refuse containers required by Ogden, Utah, are described in some detail in its specification that:

> Tightly covered garbage containers shall be provided within a reasonable distance from all trailer coach spaces. Racks or holders shall be provided for all garbage and other refuse containers. Such container racks or holders shall be so designed and constructed as to prevent containers from being tipped and to minimize spillage and container deterioration and to facilitate cleaning around them." *Code, Sec. 26-3-9*

The site and placement of the containers is more emphasized in the comprehensive section of the New Orleans ordinance on mobile home parks which details that:

> "Sufficient containers for the storage, in a sanitary manner, of one week's accumulation of garbage and trash shall be provided. Three or four cubic yard containers, approved by the Department of Sanitation shall be provided for the disposal of garbage and trash. The unit(s) shall be located in an enclosed (fenced) area, paved with asphalt or concrete . . . provided with coping and floor drain connected to the sanitary sewer. The area shall be maintained free of insects and rodents. The location of the pick-up area and the containers must be approved by the Department of Sanitation. No garbage or trash will be picked up at the individual trailer sites. It shall be the obligation of the owner-operator of a Trailer Park to require that all garbage and trash be disposed of in a sanitary manner and it shall be his responsibility to maintain the Park free of litter and debris." *Code, Sec. 36A-7*

Paving of tourist court surfaces is required in San Antonio, Texas, by the provision that:

> "All land used as an automobile tourist court . . . shall be hard surfaced, and shall be located on well drained sites of ample size approved by the public health department. . . ." *Code, Sec. 37-13*

Broad-scale brevity is typified by the Euless, Texas, requirement that:

> "All owners or operators of any tourist court, trailer courts and hotels, inns and rooming houses shall provide every practical facility essential to keeping the entire area of each of said courts in a sanitary condition." *Ord. No. 27 of 3/7/55, Sec. 16-C*

Handbills

Unsolicited advertising leaflets and like materials, which are prolific sources of litter, are generally characterized as "Handbills" in numerous ordinances for the control of their distribution. The NIMLO model is a multi-section ordinance directed toward various facets of the problem. In the most direct approach, it deals with "throwing handbills broadcast in public places" as follows:

> "It shall be unlawful for any person to deposit, place, throw, scatter or cast any commercial handbill in or upon any public place within this City; and it shall be also unlawful for any person to hand out or distribute or sell any commercial handbill in any public place; *Provided, however*, that it shall not be unlawful for any person to hand out or distribute, without charge to the receiver thereof, any non-commercial handbill in any public place to any person willing to accept such non-commercial handbill." *Sec. 8-104*

Distribution into or onto motor vehicles is covered in the next section of the Model, thus:

> "It shall be unlawful for any person to distribute, deposit, place, throw, scatter or cast any commercial or non-commercial handbill in or upon any automobile or other vehicle. The provisions of this section shall not be deemed to prohibit the handing, transmitting or distributing of any non-commercial handbill to the owner or other occupant of any automobile or other vehicle, who is willing to accept the same." *Sec. 8-104*

Substantially similar provisions are found in numerous city ordinances—e.g., of Dallas *(Code, Sec. 7A-11)* and Denver *(Code, Sec. 352.13-1)*—and for "advertising matter" in Berkeley, California. *(Ord. No. 2847-N.S., Sec. 5)*.

The "consent" specified to legalize the distribution is that of the "owner or person in charge of" the vehicle in San Antonio, Texas, *(Code, Sec. 26-5)* and of its "owner or custodian" in Des Moines, Iowa, *(Code, Sec. 3-2)*—the former covering". . . any circular, dodger, handbill or other advertising or other advertising or printed matter of any character whatsoever . . ." and the latter". . . any kind of paper, circular, card, dodger, handbill or other advertising matter . . ."

Distinctions as to the activity or inactivity of the vehicle are illustrated by pertinent excerpts (emphasis supplied) of the ordinances of Greensboro, North Carolina, Peoria, Illinois, and Salina, Kansas—respectively:

> "It shall be unlawful to distribute advertising or matter of any kind by placing the same in or on any motor vehicle *that is parked* on any street, in other public places, or in a public or private parking lot or facility . . ." *Code, Sec. 3-2*
>
> "No person shall. . . cause to be distributed, any handbill, circular, dodger, pamphlet or paper of a commercial advertising nature by leaving or placing such advertising matter in or upon any vehicle . . . while such vehicle *is parked or stopped* upon any street, avenue, alley, sidewalk or other public place in the city." *Code, Sec. 22-1*
>
> "It shall be unlawful . . . to place or cause to be placed, any handbills, circulars, cards, posters, leaflets, pamphlets, booklets, showbills, or other advertising matter in, or attach the same upon any part of any motor vehicle, while such motor vehicle *is in use* upon the streets *or standing parked* upon the streets or public parking lots . . ." *Code, Sec. 3-1*

The orientation to littering is clearly apparent in the stipulation by Grand Junction, Colorado, that:

> "It shall be unlawful to post, affix or distribute any handbill, poster, placard, circular, writing, paper or similar device in any vehicle or in such a manner that it is liable to be blown or scattered about in the city." *Code, Sec. 3-3*

Automotive and other locations, pedestrians and motorists, are combined in the prohibitory ordinances of certain cities, of which those of Concord, New Hampshire, Daytona Beach, Florida, New Rochelle, New York, and Saginaw, Michigan, respectively, are here excerpted:

> "No person shall, in any . . . public place . . . distribute to the persons or place in any vehicle, there being or passing, any handbills, cards, papers or advertising matter of any kind or description . . ." *Code, Sec. 10.1*
>
> "It shall be unlawful to distribute to pedestrians . . . or to throw into or upon any bus or automobile or other vehicle, any handbill, dodger or advertising notice of a commercial character." *Code, Sec. 3-5(1)*
>
> "No person shall throw, cast or distribute . . . any commercial handbill, circular, card or other commercial advertising matter whatsoever, in or upon any street or public place . . . or in or upon any motor vehicle . . ." *Code, Sec. 7-8*
>
> "No person shall distribute, throw, drop or scatter in any . . . public place or in or upon any vehicle . . . any posters, handbills . . . or other . . . advertising in such a manner as to result in the littering of any street, alley or public place." *Code, Sec. 107.1*

In relation to non-vehicular distribution a "pattern" is found in the handbill ordinances of several cities—for which that of Des Moines, Iowa, will serve for a starting point:

> "It shall be unlawful for any person to distribute or to throw or to cause to be thrown or scattered any kind of paper, circular, cards, dodger, handbills or advertising matter of any kind upon the public highways, streets, avenues, boulevards, alleys and public passageways, public parks or public buildings . . ." *Code, Sec. 3-1*

San Antonio, Texas, directs the proscription against ". . . any handbill, circular, card, booklet, placard or other advertising matter whatsoever . . ." (Code, Sec. 26-4), which is also the description used by the ordinances of Albany, Georgia, (Code, Sec. 19-12) and Newport News, Virginia (Code, Sec. 3-2) the locale in the latter being ". . . in or upon any street or sidewalk or upon any public parking lot."

Phraseology of different patterns is applied by the ordinances of Owensboro, Kentucky, and El Paso, Texas,—which provide, respectively, that:

> "It shall be unlawful for any person to distribute or scatter any handbills, advertising cards or other advertising matter on or upon any of the streets, alleys or public ways of the city . . . or to permit any such cards, papers or other advertising to be scattered upon the streets, sidewalks, alleys or other public ways in the city." *Code, Sec. 13-40*
>
> "No person shall hand out, scatter, throw or distribute commercial handbills, circulars, cards, or advertising devices in any street, public park, public grounds, or public building . . ." *Code, Sec. 18-6*

Distribution to Private Premises

Three sections of the NIMLO model relate to distribution of handbills to private premises, thus:

> "It shall be unlawful for any person to distribute, deposit, place, throw, scatter or cast any commercial or non-commercial handbill in or upon any private premises which are temporarily or continuously uninhabited or vacant." *Sec. 8-106*
>
> "It shall be unlawful . . . to distribute . . . any commercial or non-commercial handbill upon any premises, if requested by anyone thereon not to do so, or if there is placed on said premises in a conspicuous position near the entrance thereof, a sign bearing the works: 'No Trespassing,' 'No Peddlers or Agents,' 'No Advertisement,' or any similar notice, indicating in any manner that the occupants of said premises do not desire . . . to have any such handbills left upon such premises." *Sec. 8-108*
>
> "No person . . . shall distribute . . . any commercial or non-commercial handbill in or upon any private premises which are inhabited, except by handling or transmitting any such handbill directly to the owner, occupant, or any other person then present in or upon such private premises; *Provided however*, that in case of inhabited private premises which are not posted as provided in this ordinance, the aforesaid . . . person, unless requested by anyone upon such premises not to do so, may place or deposit any such handbill . . . if such handbill is so placed or deposited as to secure or prevent such handbill from being blown or drifted about such premises or elsewhere . . ." *Sec. 8-108*

Substantially the above provisions are carried in such ordinances as those of Newport News, Virginia, Dallas, Texas, and Berkeley, California—with the latter adding, as to poste premises,

> "It shall be unlawful to ring the bell or to knock at any residence, building or place for the purpose of distributing or circulating advertising matter where such a sign is displayed." *Ord. No. 2847-N.S., Sec. 7*

Denver *prescribes* the distribution procedure, and puts "teeth" in its regulations, as follows:

> "If circulars, handbills, advertisements, or other literature are distributed to private premises . . . the distribution shall be only in compliance with the following procedure:
>
> (1) The circulars, handbills, advertisements, or other literature shall first be firmly bound or folded or shall be securely affixed or confined in some position near a principal entrance to the premises to obviate the likelihood of dispersal by the wind or the littering of any area.
>
> (2) It shall be unlawful not to comply with the procedure outlined . . . and it shall be unlawful to select or employ any person who distributes circulars, handbills, advertisements, or other literature except in accordance with such procedure.
>
> (3) Proof that any particular area was found unduly littered and unsightly by a specific kind of circular, handbill, advertisement or other literature which was distributed by an identified distributor shall be *prima facie* evidence of a violation . . . by such distributor." *Code, Sec. 352.13-2*

Licensing Distributors

Among other approaches the NIMLO model contemplates controlling the problem of handbills by control of those who engage in their distribution. The pertinent provisions, here sharply abbreviated, are as follows:

> "(a) It shall be unlawful . . . for any person to distribute commercial or non-commercial handbills, without . . . complying with . . . this ordinance . . . *Provided*, that nothing contained herein shall apply to any person advertising . . . upon his own premises . . . (b) Any person desiring to engage . . . in the business of distributing . . . handbills for hire, shall . . . receive . . . a license . . . for the period prescribed by . . . this ordinance and . . . the municipal code. Such applicant shall make written application . . . upon a form . . . (which) shall contain . . . the name, the business address, and a brief description of . . . the business to be conducted . . . (c) Without excluding other just grounds . . . the City Council . . . may revoke any license . . . under an application . . . to obtain a license by means of false or fraudulent representations or for violation of this ordinance, or any other grounds specified by law. . . . License fees . . . shall be . . . (rates optional) . . . *Provided*, that persons acting for license as agents or employees, . . . shall not be required to obtain a license . . . but . . . shall comply with each and all of the other provisions hereof . . ." *Sec. 8-110*

City ordinances noted in this study, however, limit licensing to distributors of "advertising matter"—i.e., in the NIMLO language, "commercial" handbills only. Newark, New Jersey, requires each distributor of ". . . Handbills or other advertising matter . . ." to secure a no-fee permit from the Chief of Police, based upon an application, accompanied by a photo and disclosing his name and address, age, height and weight, birthplace, marital status, place and length of residence, criminal record and name and address of employer. The ordinance further stipulates (with emphasis supplied) that:

> "The chief of police shall have the power to grant the permit . . . (but) . . . *shall refuse* to issue a permit in all cases where the application upon its face, or upon further investigation, . . . shows that the applicant is not of good character or that he is distributing advertising matter for a project or a business that is *not free from fraud*. Every permit . . . shall specify the number of hours or days that the permit shall specify the number of hours or days that the permit shall be in effect. The chief of police *shall revoke* any permit . . . for failure or refusal . . . to comply with . . . this article. A copy of the permittee's photograph shall be carried on his permit, . . . The permittee shall exhibit his permit . . . on request. The permittee shall be courteous . . . and shall not importune nor annoy any of the inhabitants . . . and shall conduct himself in a lawful manner . . . On expiration of the permit the holder thereof shall surrender the same to the chief of police. This article *shall not . . . authorize any person to scatter or throw upon the streets, sidewalks, alleys or public places in the city, poster, handbills, advertisements or paper, . . .*" *Code, Secs. 8124 - 8.28*

Simpler regulatory ordinances encompass both bill posting and handbill distribution—e.g., at Pocatello, Idaho, and Kalamazoo, Michigan, which respectively provide that:

> "Any person desiring to do bill posting, distribute handbills or perform sign advertising shall be licensed by the Clerk upon the payment of . . . $25 . . . for the term of one year . . . and said person shall perform . . . in a good, lawful and proper manner in compliance with the provisions . . . governing the character of the matter . . . distributed and the manner of . . . distributing the same." *Code, Sec. 5-3-2*
>
> "It shall be unlawful . . . to engage in, or carry on, the business of bill posting, bill distributing or the distribution of advertising matter, . . . without first obtaining a license . . . (which) . . . shall be obtained by making application . . . to the City Clerk. Such application shall . . . specify whether bill posting and bill distributing alone, or . . . with the distribution of advertising matter are desired to be engaged in . . . The license fee for bill posting, bill distributing and the distribution of advertising matter shall be . . . $20 . . . (and) . . . for bill distributing and the distribution of advertising (only) . . . shall be . . . $8 . . . per license year. . . ." *Code, Sec. PL1311*

As is the case with the three foregoing, Council Bluffs, Iowa, exempts those who distribute handbills advertising their own business (limiting the exemption to "any local merchant with a permanent place of business within the city"), but also provides a preferential rate for distribution "incidental" to a business, thus:

> "Any person, . . . who follows the calling . . . and occupation and engages in the business of distributing handbills, . . . shall be required to secure a permit . . . and the fee . . . shall be twenty-five dollars per year . . . Any person . . . who shall distribute handbills . . . as an incident to the conduct of his business or profession but who does not follow the calling . . . and business of an advertising distributor shall be required to secure a permit . . . and the fee . . . shall be five dollars per year; *provided* . . . the requirements . . . shall not be applicable to public or charitable enterprises or entertainments where private gain or profit is not sought." *Code, Secs. 3.11.030 and 3.11.040*

General Exemptions

While the NIMLO model provides merely that "The provisions of this ordinance shall not be deemed to apply to the distribution of mail by the United States, nor to newspapers as defined in this ordinance." (Sec. 8-111), certain cities go further in exempting particular handbills from their controlling ordinance. San Francisco exempts in relation to content, thus:

> "This section shall not . . . prohibit or restrict the distribution of written or printed matter devoted to the expression of views, opinions, beliefs or contentions relating to religious, political or sociological subjects, or to public or civic affairs, or to labor disputes or other controversies or to community, state, regional, national or international affairs; or which are aimed to redress any grievance, or which otherwise are not distributed for the purpose of soliciting business, trade or custom; nor . . . to include the printed notice, of an event which is not arranged for profit or to

> stimulate the business, trade, or traffic of the person who causes the dissemination of the notice, even though a monetary contribution of an admission fee be requested or accepted in connection with such event." *Police Code, Sec. 685(b)*

New Orleans considers not only content but also size and transmission in framing the rather dubious exemption (emphasis supplied) that:

> ". . . nothing in this section shall interfere with or prevent the distribution of invitations to religious meetings, *nor prevent* the distribution of cards, dodgers or handbills measuring not more than eight and one-half inches in width by eleven inches in length, directly from the hand of the distributor into the hands of another person." *Ord. No. 828 M.C.S., Sec. 3-5, as amended*

Finally, numerous cities follow the lead of the Albany, Georgia, ordinance, that:

> ". . . is not intended to prevent the lawful distribution of anything other than commercial and business advertising matter." *Ord. No. 1379 of 9/12/44*

Permanently mounted ground level billboards are likely to be a source of litter, especially as a result of bill-posting changes. The NIMLO model on "Signs" provides merely that:

> "All ground signs and the premises surrounding the same shall be maintained by the owner thereof in a clean, sanitary, and inoffensive condition, and free and clear of all obnoxious substances, rubbish and weeds." *Sec. 12-323 (e)*

Operator responsibility for general site cleanliness is the evident objective of two Texas ordinances—of El Paso and San Antonio—which respectively provide that:

> "It shall be the duty of any person maintaining billboards within the city to keep the property enclosed, or partly enclosed by such billboards, free from the accumulation of filth, weeds, papers and trash." *Code, Sec. 18-4*

> "All billboards within the city shall be kept in a safe and sanitary condition . . . The duty shall rest upon any person owning, maintaining or controlling billboards to see that the ground immediately surrounding such billboards or any other ground sign owned, maintained or controlled by him is kept in a clean and sanitary condition." *Code, Sec. 34-44*

The bill-posting operation is accented in ordinance provisions of San Francisco, California, and Peoria, Illinois, respectively specifying that:

> "No person, firm or corporation shall scatter, daub or leave any paint, paste, glue, or other substance used for painting or affixing advertising matters upon any public street or sidewalks or scatter or throw or permit to be scattered or thrown any bills, waste matter, paper, cloth or materials of whatsoever kind removed from billboards on any public street or on private property." *Police Code*, Sec. 87

> "It shall be unlawful for any person engaged in the business of outdoor advertising to permit any refuse resulting from the erection or maintenance of any signs, display boards or billboards erected or maintained by such licensee to accumulate anywhere in the city, except by placing it in properly established and maintained refuse receptacles. . . . All refuse resulting from the operation of the business of an outdoor advertiser must be carefully gathered up and disposed of." *Code, Sec. 23-7*

Vending on or Along the Streets

Akin to Handbills, in their litter-producing potential, are various vending activities conducted along the streets or sidewalks and which may be called "instant refuse" operations.

A broad-gauge requirement contained in the Albany, New York, licensing ordinance for venders including hawkers, peddlers, salesmen, canvassers and solicitors "for the sale or purchase of goods, wares and merchandise in the public streets and places" prescribes that the licensee:

> ". . . shall not directly or indirectly cause or permit the public streets and places to be littered with papers, wrappings or other debris or refuse; . . ." *Ord. of 6/16/52, Sec. 9(c)*

Vehicular sales of food products and beverages via "mobile canteen units" in Little Rock, Arkansas, and "mobile restaurants" in Tacoma, Washington, are governed by ordinances which respectively require that:

> "All waste products shall be disposed of so as not to create any nuisance upon public or private property. The owner or operator of any mobile canteen unit shall provide suitable containers, approved by the public health director, for the disposal of all waste products, including used paper cups and containers." *Code, Sec. 14-26(d)*

> "Operators of mobile restaurants must at all times keep the premises upon which said restaurants are located clean and sanitary and free from all litter and refuse and provide proper receptacles for all refuse, etc." *Ord. No. 17582 of 4/14/64, Sec. 10*

A similar provision relates to vehicular vending of ice cream in Rockville, Maryland stipulating that:

> "All vehicles shall be equipped with a suitable receptacle in a location convenient to patrons for the disposal of wrappers and other disposable products sold from the vehicle." *Code, Sec 13-1.14(f)*

Retail foodstuffs establishments in their own premises adjacent to public streets and sidewalks have their litter-potential regulated and policed by such ordinances as those of such divergent cities as Des Plaines, Illinois, and Franklin, New Hampshire, which respectively require that:

> "Any person engaged in the business of sale of foodstuffs, including ice cream, for consumption on or off the premises and served in paper boxes, containers, dishes, wastepaper materials or containers of like substance shall provide a receptacle within their premises for the disposal of such wastepaper and shall not permit or allow any person to place, leave, throw or scatter the wastepaper and refuse in or upon the streets, sidewalks or public grounds abutting the premises; provided, however, that in case any paper or wastepaper shall for any reason be scattered upon the streets, sidewalks or public places, and emanating from the business, the same shall forthwith be removed by the person in charge of the business." *Code, Sec. 8-15-1(p)*

> "Every person or corporation keeping for sale at retail on premises adjoining a public street, fruit, nuts or other goods from which waste is liable to be thrown upon such street shall keep the highway abutting . . . free and clear of waste substances and matter from such class of goods as kept for sale by him at such store, and shall keep and maintain in a wholesome condition all such receptacles for waste matter as may be located by the City upon or adjoining the premises occupied by him." *Code, Chap. 11, Sec. 3*

Sidewalk Photographers

Sidewalk photographers who snap "candid" photos of passers-by on downtown streets are usually producers of "second-hand litter" as a great many of their inadvertent "subjects" may promptly discard the serially-numbered "order form" handed to them. Milwaukee, Wisconsin, licenses the occupation, but provides that grounds for revocation of a license shall include:

> "Littering the street or highway with cards, circulars or literature or any other paper or material." *Code, 84-2.5(a)*

San Antonio, Texas, not only requires the sidewalk photographer to secure a permit, which is good only for a designated location (on one side of the street in a specific block), but also provides that:

> "Each permit holder shall be required to keep the street and sidewalk within three hundred feet in both directions from his location free from discarded handbills, circulars, or advertising matter used incident to his business." *Code, Sec. 28-13*

This kind of litter is eliminated by prohibiting this type of enterprise as at Greensboro, North Carolina, and Portland, Oregon, which respectively provide that:

> "It shall be unlawful to use the streets or sidewalks of the city for the purpose of operating a photographer's business whereby photographs are snapped or made of passers-by and a card, ticket, tag, emblem or other thing is given to any person who may by the payment of a sum of money obtain a photograph or picture." *Code, Sec. 18-14*

> "It shall be unlawful for any person . . . to engage in business as a photographer taking photographs of any person or persons upon any street, sidewalk, alley, or public way or place, . . . without such person's prior consent; . . ." *Police Code, Sec. 16-2023*

In the latter city the Council explained why it was foreclosing pursuit of the occupation, which:

> ". . . has resulted in a situation which hereby is found to be a public nuisance in that the photographing of persons without their prior consent is a violation of the individual's right of privacy, and in the littering of streets, sidewalks, doorways and business premises with order blanks, envelopes, cards, and other printed matter distributed by such sidewalk photographers, . . ." *Ord. No. 96086 of 1952, Sec. 1*

Flower Vendors

In San Francisco, the Director of Public Works is empowered to issue permits for day-and-evening operation of "sidewalk flower-vending stands" (7 a.m. to 9 p.m.) at specified locations. The ordinance provides that:

> ". . . the sidewalk and street surrounding each stand shall be kept free of rubbish, cuttings or debris resulting from the operation of the stand: —however, "No rubbish or cuttings shall be deposited in any public waste container." *Public Works Code, Sec. 161(g) and (f)*

Produce Peddlers

The vehicles of produce peddlers are regulated as "mobile markets" in Richmond, California, with requirements that:

> "... Mobile markets shall be kept in a clean and sanitary condition at all times, and no waste, litter, or other material shall be allowed to drop on the streets or other public places. ..." and "... shall provide in their vehicle a metal garbage can with a tight-fitting cover to be used for the disposal of waste matter." *Ord. No. 1746 of 10/16/61, Sec. 4.4 (F-20) and (F-19)*

Site Cleanup of Circuses, Carnivals, etc.

The best way to avoid being left with a wasteland of litter when a circus or carnival leaves town seems to be to require that its operators, upon obtaining their license, must also post a bond to assure site cleanup at the end of their stay. A selection of representative ordinances shows variations from $50 to $1,000 in the amount of the bond, but similarities in its application to site cleaning costs when necessary and in site inspection before releasing the security. Bonds often may also cover compliance with other ordinance requirements and safeguards (e.g., protection of city property), but excerpts herein are restricted to site cleanup aspects.

Scottsdale, Arizona, is not specific as to administration of its bonding requirement set up in its ordinance which merely provides that:

> "... the following special fees shall be charged and collected in advance for the carrying on of ... (d) Carnivals $100. p/day; $1000 cleanup bond (e) Circus $100. p/day; $1000 cleanup bond ..." *Ord. No. 123 of 7/5/61*

Certification of a cleaned-up site is prerequisite to release of the $1,000 bond in two widely separated cities—Flint, Michigan, and Dalles City (The Dalles), Oregon—as follows:

> "Before any license for a circus or menagerie, ... or amusement rides or wildwest show is issued ... the applicant shall deposit with the City Clerk a cash bond in the sum of One Thousand Dollars (1,000.00) conditioned upon the faithful observance of this ordinance and conditioned further that no damage will be done to the streets, sewers or other public or private property and that the same will be restored to the condition which existed prior to use by said licensee, and that no dirt, paper, litter or other debris will be permitted to remain upon the streets or upon any public or private property by such licensee. Such cash bond ... shall be returned upon certification of the Director of Public Works and Chief of Police ... that the property, both public and private, and streets where such circus or menagerie, ... or amusement rides, or wild west show has been held is placed in a neat condition and all debris removed ..." *Ord. No. 1894 of 3/21/66*
>
> "It shall be unlawful ... to erect or cause to be erected any temporary structure composed wholly or partly of canvas or similar material to be used as a place of amusement or for any religious, educational or recreational purposes or for any other public assemblages whatsoever ... without first ... receiving permission to do so in accordance with ... this ordinance ... (c) The applicant shall deposit ... a cash bond in the sum of $1,000.00, or a surety bond in the same amount ... conditioned further that no damage will be done to the streets, sewers, trees or adjoining property and that no dirt, paper, litter, or other debris will be permitted to remain upon the streets or upon any private property by such applicant. Such cash bond or surety bond shall be returned to the applicant upon certification by the chief of police that all conditions of this ordinance have been complied with ..." *Ord. No. 710 of 4/7/54*

Bonding requirements at lower monetary levels are more specific as to providing for cleanup city forces when the licensee does not leave the site in satisfactory condition. As an example, Albany, Georgia, provides that:

> "... Before any license is issued for a circus, carnival, or any similar performance, the applicant shall deposit ... $500 ... upon the condition that the applicant will clean up all litter caused by the applicant so that the premises will be left in approximately the same condition as they were prior to being used by applicant. ... In the event applicant fails to comply with these conditions, the City ... may cause the necessary work and improvements to be made, paying the expenses thereof out of the deposit. The balance, if any, will be refunded to applicant." *Ord. No. 206 of 12/11/51, as amended*

Another city bonding at the $500 level but evidently contemplating outright forfeiture is Reno, Nevada, whose ordinance provides that:

> "... Every person who shall exhibit any circus, caravan or managerie in the city, or exhibit or advertise the same by parading ... shall pay for and obtain a license for each exhibition, performance or parade, ... Before granting any license hereunder, the city clerk shall require each applicant to deliver to him a bond ... of five hundred dollars, conditioned that the applicant ... will, at the conclusion of the performance ... thoroughly clean, or pay for cleaning

> of the streets and alleys upon which the circus, caravan or menagerie may be, . . . and that any violation of any of the conditions of such bond shall cause a forfeiture of the same; . . ." *Code, Secs. 4.01.460, 4.01.470*

Reno also has similar provisions to cover ". . . any carnival or other performance in the open air, or under a tent . . . except a circus, caravan or menagerie . . ." *(Code, Secs. 4.01.430, 4.01.450)*

The City Manager is charged with certification of compliance for refunding the bond under the ordinance of Oak Ridge, Tennessee, which provides that:

> "It shall be unlawful . . . to conduct . . . any rodeo, wild west show, menagerie, circus, carnival, or similar type of itinerant show . . . without . . . having received permission to do so in accordance with . . . this Ordinance. . . .C - The applicant shall deposit . . . a cash bond in the sum of . . . $300 . . . conditioned that . . . no dirt, paper, litter or other debris will be permitted to remain upon the streets or upon any private property by such applicant. Such cash bond shall be returned . . . upon certification . . . that all conditions . . . have been complied with . . ." *Ord. No. 36-62 of 12/6/62*

Setting their bond requirements at $250 and specifying city cleanup when necessary are Seattle, Washington, whose ordinance covers also circus parades, and Daytona Beach, Florida, whose regulations pertain to "any tent"—thus:

> ". . . No license shall be issued to any person for any circus, menagerie, trained animal show, wild west show, or a similar show, or any combination thereof, or for a circus parade, . . . until such person has deposited . . . $250 $200 for carnivals . . . as a indemnity . . . to be used, if necessary to restore the ground where such show is held to a sanitary condition, . . ." *Ord. 92204 of 7/18/63*

". . . The erection of any tent within the . . . City of Daytona Beach without a permit . . . is prohibited. . . . Before any permit is issued, applicants shall post a cash bond in the amount of . . . $250 . . . to insure cleaning of the premises after the tent is removed. Such bonds shall be forfeited in the amount of $10 per day . . . for each day . . . that the premises shall not be cleaned of all debris, garbage, refuse and signs. In the event it becomes necessary for the City of Daytona Beach to clean the premises, the cost of such cleaning shall be deducted from the bond." *Ord. No. 66-260 of 1/18/67*

Bonus in the comparatively small amount of $50 are specified in the ordinances of two cities which make post-departure inspections. Pocatello, Idaho, inferentially escheats the deposit on non-compliance under its ordinance providing that:

> ". . . Before a license shall be issued . . . a circus, menagerie or carnival, . . . shall be required to deposit with the Clerk a cash bond of . . . $50 . . . to be a guarantee that . . . the grounds or streets used for such operation be cleaned of all trash, paper and other debris . . . Before returning said bond . . . the Clerk shall have such grounds inspected for the purpose of ascertaining that such cleaning has been done." *Code, Sec. 5-1-7*

Dollar amounts in the 1925 ordinance of Council Bluffs, Iowa, are obviously outdated, but its language provides that the licensee shall pay for the city's site inspection in addition to paying its cleanup costs (with an over-write) if required, thus:

> ". . . At the time the City Clerk shall issue any license to any circus, menagerie, show or other exhibition to be given in tents or other temporary enclosure . . . the Clerk shall require the licensee to deposit . . . fifty dollars as a guaranty that the premises and surrounding streets . . . shall be left in a clean and sanitary condition. . . . Upon the removal of the licensee . . . the Clerk shall direct the City Engineer to make an inspection of such premises, and if the same are left in a clean and sanitary condition, the Clerk shall refund . . . forty-eight dollars, retaining the balance to reimburse the city for the expense of making such examination. . . . In the event such examination shows a breach of such guaranty, the City Engineer shall direct the cleaning of such premises and surrounding streets, keeping an accurate record of the cost of such work . . . including a fee of five dollars for such superintendence and the Clerk shall deduct from such deposit the amount thereof and refund the balance . . ." *Ord. 2652 of 5/4/25*

Confetti

Even the parade-related minuscule "litter" of *confetti* is placed under legislative restraint in some cities. In Boise, Idaho, the City Council granted itself some latitude for exceptions on providing that:

> "It shall be unlawful for any person on the streets or in any public places, to throw upon any person confetti, . . . provided, however, that the Council may . . . suspend the provisions of this Section . . . only for limited periods during carnivals, fairs, chautauquas or other occasions of like character . . ." *Code, Sec. 6-1-28*

Exceptions were also made, but for type rather than time, in far-distant Columbia, South Carolina, whose ordinance provides that:

> "It shall be unlawful for any person to engage during any festival occasion or at any other time in the throwing of confetti (excepting that known and designated as "ribbon confetti," being and

> consisting of rolls of lightest tissue), flour, rubber ball, iodoform or other drugs or any material whatsoever serving the same purpose, upon any other person. . . ." *Code, Sec. 23-9 (b)*

The latter ordinance forbids not only the use, but the sale of confetti (with the same exception) as follows:

> ". . . It shall be unlawful for any person to sell or offer for sale . . . "confetti," excepting, however, what is known and designated as ribbon confetti, being and consisting of long rolls of lightest tissue paper." *Code, Sec. 23-9 (a)*

San Antonio specifically includes fiestas and festivals within its ban on the throwing of confetti (which provides no exceptions), thus:

> "It shall be unlawful for any person when on any street, park, public ground or other public place during any festival, carnival, fiesta or other public gathering, celebration or demonstration, to throw, spread, place, put, apply or otherwise use any confetti . . . talcum powder, flour, meal . . . or to have in his possession any of such . . . materials or substances whatsoever for such use." *Code, Sec. 26-9*

STORAGE AND DISPOSITION OF GARBAGE AND RUBBISH

The whole gamut of subjects covered, and problems dealt with, in a comprehensive ordinance to establish and regulate a municipal refuse collection system, of whatever type, goes far beyond the scope of our present interest within the bounds of this current study. Some aspects of typical enactments—such as construction of collection vehicles and spillage therefrom, authorized and unauthorized dumping, and the disposition of dead animals and garden refuse—are considered elsewhere in this exploration of pertinent ordinances. Some other matters that are very pertinent and sometimes thorny aspects of a comprehensive "system" ordinance—such as separation and/or wrapping of garbage, collection points and frequency, and service charges or other means of financing—are not considered germane to this study. The primary areas here significant appear to be the sanitary (not generally safety or efficiency) aspects of regulations relating to containers for, and other means of storing, refuse prior to scheduled pick-ups, at whatever points and times they may occur. Other minor related aspects will also be considered in due course.

Within the outlined scope, the NIMLO model "Municipal Refuse Collection" ordinance provisions run as follows:

> "Refuse containers shall be provided by the owner, tenant, lessee, or occupant of the premises. Refuse containers shall be maintained in good condition. Any container that does not conform to the provisions of this ordinance . . . shall be promptly replaced upon notice. . . . Garbage containers shall be made of metal, equipped with suitable handles and tight fitting covers, and shall be water tight. . . . Garbage containers shall be of a type approved by the City Health Officer and shall be kept in a clean, neat and sanitary condition at all times. . . . Rubbish containers shall be of a kind suitable for collection purposes . . . No person shall place any refuse in any street, alley or other public place, or upon any private property whether owned by such person or not, within the City except it be in proper containers for collection or under express approval granted by the Director. Nor shall any person throw or deposit any refuse in any stream or other body of water. Any unauthroized accumulation of refuse on any premises is hereby declared to be a nuisance and is prohibited. . . . No person shall cast, place, sweep or deposit anywhere within the City any refuse in such a manner that it may be carried or deposited by the elements upon any street, sidewalk, alley, sewer, parkway or other public place, or into any occupied premises within the City." *Sec. 10-605 (3) and (4)*

Containers

Considerations most germane to refuse (and particularly garbage) containers relate to usage, adequacy, construction, and condition.

The ordained specifications for the construction of refuse containers which follow (with emphasis supplied as necessary) range from sketchy to detailed, in phraseology ranging from rigorous to permissive. Reno, Nevada, and Cranston, Rhode Island, leave the material to be used unspecified:

> "It shall be the duty of every tenant, lessee or occupant . . . and of every other person having garbage, to provide . . . suitable and sufficient watertight cans or receptacles with suitable bales or handles and each having a tight-fitting cover, for receiving and holding without leakage, or escape of odors, all garbage which would ordinarily accumulate on the premises in one week's time, and all garbage shall be placed in such receptacles. . . . " *Code, Sec. 5.28.060*

> "The owner or occupant . . . provide a covered, watertight receptacle . . . and shall deposit . . . garbage in such receptacle." *Code, Sec. 11-11*

In Florida the material must be "impervious" at Daytona Beach and "solid and durable" at Miami:

> "Garbage shall be . . . placed in watertight containers or receptacles *of impervious material* which are provided with tight-fitting covers . . . " *Code, Sec. 17-9 (1)*
>
> "The container shall be a water tight receptacle, which . . . shall have a tightly fitting lid equipped with a handle. Such container shall be made of *a solid and durable material*. The container must not have any inside structures such as inside bands and reinforcing angles, or anything within that would prevent the free discharge of the contents. . . . " *Ord. No. 6899 of* 7/18/61, Sec. 2

Metal is predominantly the most specified material, for which simpler requirements are typified by ordinance provisions of Greenwich, Connecticut, Grand Forks, North Dakota, and Great Falls, Montana, as follows:

> "Covered watertight metal containers shall be provided . . . for the storage of refuse. . . . " *Sanitary Code, Sec. 58.2*
>
> "Each property owner or occupant shall furnish . . . one or more suitable *metal garbage cans* equipped with close fitting tops . . ." *Code, Sec. 13-0504*
>
> "It shall be the duty of property owners . . . and . . . persons occupying business places and residences . . . to provide . . . portable vessels or cans for holding garbage. Such vessels or cans . . . shall be *metallic*, . . . " *Code, Sec. 14-1-5*

A preference for *galvanized* metal is expressed in the ordinances of Owensboro and Louisville, Kentucky, thus:

> "Containers provided as herein required shall be of metal, *preferably of galvanized iron or other nonrusting metal* of substantial construction, with tight fitting covers and water tight . . . " *Code, Sec. 9-9*
>
> "Waste containers for combustible waste shall be of metal, *preferably of galvanized iron or other nonrusting metal*, of substantial construction, with tight-fitting covers, and watertight. . . . " *Public Ways and Services Code, Sec. 913.05*

A requirement for this type of metal is imposed at Kalamazoo, Michigan, St. Minnesota, and Lincoln, Nebraska (the latter with further cover specification), respectively as follows:

> "Garbage containers . . . *shall be galvanized metal* containers . . . in good repair, leak proof, rodent proof and free from holes." *Public Health Code, Sec. VII 1-a*
>
> "The owner, occupant or lessee of every buidling . . . in which any garbage is produced, shall maintain sufficient, proper and suitable containers for receiving and holding garbage. Containers *shall be of galvanized iron* or other metal which will not easily rust and which can be readily cleaned, shall be smaller in diameter at the bottom than at the top, shall be provided with a close, well-fitting lid of the same material, . . . " *Code, Sec. 320.10*
>
> "It shall be the duty of every householder . . . to maintain one or more receptacles for . . . household refuse, which *shall be of galvanized metal* with matching cover, shall be water-tight and fly-tight; the cover shall be *a recessed lid constructed with at least a one-inch extension rim on all sides*, overlapping the sides of the receptacle, to prevent the entrance of rain water into the receptacle. . . . " *Code, Sec. 8.28.170*

A variation on requiring metal is provided by the Duluth, Minnesota, stipulation that:

> "It shall be the duty of every tenant, lessee or occupant . . . to provide . . . watertight vessels or cans to hold all of the garbage which accumulates on such premises . . . Such vessels or cans shall be . . . provided with handles and a tight and securely fitted cover . . . and shall be constructed of *or lined with* metal in such form and manner as to make them watertight. . . . " *Legislative Code, Sec. 24-12*

Containers of metal or *plastic* construction are authorized by such ordinances as those of Richmond, Virginia, and El Paso, Texas, which follow:

> "Containers for refuse shall be of metal, *plastic* or other fire resistant material, . . . with tight-fitting covers, watertight, and shall be kept in good, serviceable condition, kept clean, and covered at all times." *Code, Sec. 30-11*
>
> "All cans shall be made of *plastic* or galvanized iron, or lined with galvanized iron, . . . shall be watertight, . . . shall be provided with a close-fitting lid, and shall be kept in good repair at all times." *Code, Sec. 11-3 (1)*

Acceptable container materials are enlarged to include *rubber* and other materials at Fresno, California, and specially fabricated *paper bags* at Salt Lake City, Utah, as per the following ordinance excerpts:

> "The occupant, tenant, or lessee . . . shall provide and keep in an accessible place and where they will not constitute a nuisance, garbage receptacles, equipped with handles and tight fitting covers, constructed of galvanized metal, *rubber*, plastic, or other material approved by the Superintendent of the Waste Disposal Division for receiving and holding . . . garbage . . ." *Code, Sec. 9-402*

> "Every owner, lessee or occupant of any building, premises or place of business, shall provide . . . suitable and sufficient garbage receptacles, either metallic receptacles with tight fitting lids *or properly and sufficiently treated weather-resistant paper bags manufactured specifically for use in garbage and refuse collection* . . . for receiving and holding garbage, market waste and other refuse . . . All garbage and market waste must be placed in rain-proof and fly-proof receptacles, either a metallic container with proper covers *or weather-resistant paper bags specifically for use in garbage and refuse collection having a method of closing the bag tightly* . . . " *Code, Secs. 18-2-15*

Containers of metal or other *approved* materials are allowable under the Richmond, California, ordinance, and at Seattle, Washington, via a "definition" in its ordinance:

> "Every owner or person in . . . control of any boarding house, . . . dwelling house or flat . . . shall provide . . . a watertight galvanized metallic can, *or such other type of container as may be approved by the Director of Public Health*, with suitable bails or handles and with tight-fitting cover . . . " *Code, Sec. 9.20.030 (c)*

> " 'GARBAGE CAN' means round watertight sheet metal raised bottom container . . . fitted with two sturdy handles, one on each side, and a tight cover equipped with a handle, except in the case of 'sunken cans.' *The term shall also apply to containers of other material . . . when approved by the City Engineer.*" *Ord. No. 91356 of 8/7/62, Sec. 1-L*

Container materials are wholly matters for *approved* by city officials in Los Angeles, California and in Worcester, Massachusetts, under their respective stipulations that:

> "It shall be the duty of every owner, manager, or person in . . . control of any boarding house, restaurant, hotel, apartment or eating house, and every person occupying a dwelling or flat . . . to provide, and at all times to keep, portable vessels, tanks or receptacles for holding garbage. Each vessel, tank or receptacle shall be constructed water tight . . . and provided with handles and a tight fitting cover. Each such vessel, tank or receptacle and cover shall be *made of such materials as may be approved for such use by the Board (of Public Works) and by the City Council*. The cover shall not be removed except when necessary to place garbage therein or to remove garbage therefrom. . . . " *Code, Sec. 66.02 (a)*

> "Any person in control of any premises where garbage shall accumulate shall provide on the premises a covered, watertight receptacle, *of such . . . type as the commissioner of public works shall determine*, for such garbage. . . . " *Code, Chap. 6, Sec. 2*

Finally, a rather unusual *location* requirement is imposed by Sandusky, Ohio, and an *option* as to containers is offered at Modesto, California, respectively as follows:

> "Garbage containers shall be made of galvanized or non-corrosive metal, equipped with suitable handles and tight fiting covers, and shall be water tight. . . . They shall be kept in a neat, clean and sanitary condition at all times, and *shall not be placed in direct contact with the earth.*" *Board of Health Resolution No. 102 of 4/25/60, Sec. 5 (b)*

> "All garbage . . . shall be placed . . . in a metal container . . . of a design satisfactory to the Health Officer, which container shall be kept clean . . . and shall at all times be closed against the access of flies and rodents to the contents thereof. . . . *If the producer thereof shall elect to segregate non-putrefactive material from the other garbage, the said non-putrefactive material may be placed in a box or barrel located near the said galvanized container, but the material so segregated shall be kept in a dry condition* . . . " *Code, Sec. 5-5.03*

Storage Areas and Circumstances

The cleanliness, usage, and construction of refuse storage areas are subjects of municipal legislation in Wauwatosa, Wisconsin, Wichita, Kansas, and Miami, Florida, respectively as follows:

> "Each owner . . . or occupant of every dwelling, building, or portion thereof, shall be responsible for keeping the close-fitting covers properly affixed at all times, and for maintaining the container storage area free and clear of paper, debris, ice and snow, and easily accessible to public employees. . . . " *Code, Sec. 5.09 (3) (h)(1)*

> "All garbage or refuse . . . consisting of waste animal or vegetable matter upon which rats may feed, shall be placed and stored until collected in tightly-covered, metal containers of a type prescribed by the director of public health. . . . It shall be unlawful for any person to . . . permit

> to accumulate any garbage, rubbish, trash or debris . . . on any property . . . or alley on the city so that the same shall or may afford food or harborage for rats. It shall be unlawful . . . to accumulate on any property . . . or alley in the city any salvage or waste, lumber, boxes, barrels, bottles, cans, containers or similar materials unless the same shall be placed on open racks that are sufficiently elevated . . . to prevent rat harborage." *Code, Secs. 7.48 (.130, .140, .150)*
>
> "The garbage or household trash container site shall be: (a) Situated in an easily accessible location for collectors. (b) Be a platform constructed of wood or concrete above ground level. (c) Constructed in such a manner as to discourage or eliminate possibility of rodents breeding under the platform. (d) The Director of the Department of Public Service is hereby granted full power and authority to designate the location of containers and the number of containers to be kept in each location." *Ord. No. 6899 of 7/19/61, Sec. 3*

Outlawing *accumulation of refuse* is the objective of such ordinances as those of Lewiston, Maine, and Council Bluffs, Iowa, which provide that:

> "Waste material and rubbish shall not be stored nor allowed to accumulate . . . but shall be removed from the premises as rapidly as practicable. . . ." *Code, Sec. 1314*
>
> "It shall be unlawful . . . to accumulate rubbish in such an amount as to render the property upon which the same is situated unsightly or in such an amount as to constitute a nuisance, a fire hazard, or a hazard to health. . . . " *Code, Sec. 4.12.130*

Exceptions for *firewood* are contained in the enactments (emphasis supplied) of Stroudsburg, Pennsylvania, and Reno, Nevada, thus:

> "Any unauthorized accumulation of refuse on any premises is hereby declared to be a nuisance and is prohibited. . . . A reasonable amount of material, *such as scrap lumber and fire wood*, may be kept on the premises, but it shall be racked and stacked twelve (12) inches above the ground." *Ord. No. 436 of 7/5/61, Sec. 2 (c)*
>
> "It shall be unlawful . . . to suffer, allow or permit to collect and remain upon any lot or premises, any garbage, rubbish, or waste material. Provided, however, that this provision shall not be construed as interfering with building under a building permit, or *wood neatly piled for kitchen or household use*." *Code, Sec. 5.28.030*

Advance approval for waste storage facilities of certain large commercial or residential developments is called for in Miami Springs, Florida, by an ordinance provision which asserts that:

> "Before building permits may be issued for construction of shopping centers, mulit-family dwellings or three or more dwelling units and super-markets, plans for storage of garbage and waste must be approved by the Director of Public Service as to location, accessibility and adequacy." *Ord. No. 331 of 4/11/66, Sec. 6*

Inadequate or *substandard receptacles* are dealt with in a variety of ways, as typified by the ordinances of Peekskill, New York, Fairbanks, Alaska, Pocatello, Idaho, and Greensboro, North Carolina which follow:

> "Should the container deteriorate to such an extent that the handles thereof become dangerous . . . or should it leak, it must be replaced by a proper container within one week after receipt of a written notice from the Department of Public Works of said condition." *Garbage Collection Ordinance of 3/1/60, Sec. 4 (b)*
>
> "No person shall keep on or about the premises . . . any garbage unless the same shall be kept in a metal receptacle with a tight-fitting cover. A receptacle which does not comply with this subsection in which garbage is kept is unlawful and constitutes a nuisance and shall be summarily abated by the city sanitarian or his agents by confiscation and removal. . . . " *Code, Sec. 12.204 (a)*
>
> "Oil drums, washtubs, and similar containers shall not be used for garbage and ashes. Worn out or unsightly garbage cans are to be discarded. . . . " *Ord. No. 1467 of 5/20/65, Sec. 15 (A)*
>
> "No wooden boxes, barrels, or any other wooden receptacle, or any other receptacles except approved containers shall be used for garbage or kitchen refuse, and the garbage and waste collectors shall be required to remove all such wooden boxes and other receptacles, if so used. All garbage receptacles must, at all times, be so constructed and maintained and so covered as to prevent the entrance of flies therein. Any receptacle not in good condition for the purpose used and not in conformity with the provision of this chapter will be hauled off by and disposed of as refuse." *Code, Sec. 8-6 (c)*

The latter city also places a related responsibility upon refuse collectors by the requirement that:

> "All garbage and household waste collectors shall exercise every reasonable care in handling of garbage receptacles and shall not willfully break, deface or injure the same." *Code, Sec. 8-6 (a)*

Cleanliness of garbage cans is imposed by such ordinance provisions as the following of Newport News, Virginia, Phoenix, Arizona, Vancouver, Washington, and Westport, Connecticut, respectively:

> "All receptacles used for the deposit of organic waste shall be cleaned or disinfected by the owner thereof as often as may be necessary to prevent the breeding of flies." *Ord. No. 125 of 4/27/59, Sec. 10*

> " . . . The can or container shall be maintained in a sanitary condition and shall be thoroughly cleaned as needed. . . ." *Code, Sec. 22-3*

> ". . . Each can shall be kept clean inside and out so that no odor nuisance shall exist. . . ." *Code, Sec. 6.12.110*

> " . . . Such containers shall be kept in good repair and in a sanitary condition at all times. . . . If in the opinion of the Director of Health or his agent as unsanitary or unhygienic condition exists . . . the Director of Health or his agent may require the user to take such action as is necessary to correct the situation including the construction of refuse storage bins, racks or enclosures, and the treatment of refuse, refuse containers and refuse storage bins, racks and enclosures with disinfectants, deodorizers and/or exterminating compounds. All such action shall be under the direction of, and subject to the approval of the Director of Health of his agent." *Code, Art. VI, Sec. I*

Collection Malpractices

Requirements for cleanliness in their operations are imposed upon licensed refuse collectors by ordinance stipulations in Modesto, California, and Pittsburgh, Pennsylvania, that:

> "The collector shall transfer the contents of all containers into the vehicle provided therefor without spilling any materials on stairs, walks, yards or streets . . ." *Code, Sec. 5-5.04*

> "Any person, persons, firm or corporation licensed to make collections of garbage or rubbish . . . shall (a) make such collections in an orderly manner, . . . (b) see that no garbage or rubbish is dropped or scattered on the premises from which collections are made, or on the streets . . . " *Code, Sec. 313.14*

Rummaging Through Refuse

General proscription of meddling with refuse containers is provided in ordinances of West Memphis, Arkansas, and of Boston and Gardner, Massachusetts, respectively as follows:

> "It shall be unlawful for any person or persons to damage, remove, destroy or in any manner interfere with garbage containers or the contents thereof . . . " *Ord. No. 180 as amended by Nos. 339 and 513, Sec. 9*

> "No person shall in any public way, public alley or other public place . . . or upon any roadway or walk thereof rummage in or through rubbish or refuse of any kind or interfere with any bundle of rubbish or refuse or any receptacle containing rubbish or refuse." *Code, Chap. 40, Sec. 39C*

> "No person shall overhaul or in any way disturb the contents of receptacles of waste materials set out to be removed by the City Truck or any truck engaged in the collection of waste material." *Code, Art. XXV, Sec. 18*

The latter city elsewhere extends the protection to containers even when not "set out" and incorporates some "exemptions" which are of uncertain effect (emphasis supplied), thus:

> "It shall be unlawful for anyone, *other than the tenants or occupants of the premises* on which rubbish containers are stored, *or the authorized agents, employees or licensees of the City* to disturb any refuse containers or to remove the contents thereof, or to *cause to be strewn or scattered* on the lawns, sidewalks or streets." *Ord. No. 35 of 4/2/52, Sec. 4 (a)*

Other exceptions for "authorized" persons appear in such ordinances as those of Cranston, Rhode Island, Newark, New Jersey, and Peoria, Illinois, which follow:

> "No person other than the owner thereof or a duly authorized agent of the city shall examine, disturb, interfere with or remove any of the contents of any can, box or receptacle containing rubbish, and placed by such owner upon the sidewalks or highways of the city for collection and removal by the department of public works of the city." *Code, Sec. 11-13*

> "It shall not be lawful for any person, excepting an employee of the city in the discharge of his duties, or an authorized ash, garbage and waste collector, to collect, pick in, rake up or in any way disturb the ashes, garbage or other refuse material of whatsoever nature deposited in any receptacle laid or placed on any street or public place." *Code, Sec. 15.641*

> "It shall be unlawful for any person, other than a scavenger employed or licensed by the city, or the owner, occupant, tenant or person in charge of possession of the premises for which a vessel for garbage, ashes or miscellaneous waste, or any of them, has been provided, or his agent, employees or servants, to deposit any article, substance or thing in such vessel, or to remove, displace, injure, deface, destroy, uncover or in any manner disturb such vessel, or any portion of its contents." *Code, Sec. 14-7*

Honolulu bans scattering on site or in transit, and requires cleanup, while Little Rock, Arkansas, ordains in considerable detail—as reflected by their provisions which follow successively:

> "It shall be unlawful for any person to scatter or spill or cause to be scattered or spilled any refuse set out for collection, either at the location at which it is collected or while transporting the same for disposal, unless the refuse so scattered and spilled is immediately gathered up and removed." *Ord. No. 1503 of 5/5/56,* Sec. 10 (b)

> "The commission of any of the following acts shall be deemed a nuisance: (a) Emptying the contents of any garbage can in any alley, public street, vacant lot, or any other place not provided for such use; (b) Uncovering, and leaving uncovered, the contents of any garbage can located in the city, thereby permitting flies to have access to same; (c) Disturbing the contents of any garbage can located within the city whether anything is taken therefrom or not. . . . " *Code, Sec. 15-16*

AUTHORIZED AND UNAUTHORIZED DUMPING

Indiscriminate dumping or disposal of refuse is specifically prohibited in many cities, though under quite varied "ground rules" aimed at sometimes divergent objectives. The NIMLO model "Offenses" ordinance provides simply that:

> "No person in the City shall . . . Throw or permit to be deposited or scattered upon any sidewalk, alley, street, bridge or public passageway, or upon any private property, any waste or other material of any kind." *Sec. 7-506*

An emphasis specifically on "highways" and streets ranges from the brevity of the Westport, Connecticut, stipulation that "The throwing or placing of waste materials and paper in the Highways of this Town is hereby prohibited" *(5/1/29 By-Law amended 4/3/52, Sec. 1)* to the regulations in Cranston, Rhode Island, Twin Falls, Idaho, and Sheboygan, Wisconsin, which follow:

> "It shall be unlawful for any person to throw or deposit any waste material or debris upon any public highway or platted street, or within three hundred feet thereof, except in public receptacle, or in authorized private receptacles for collection . . . " *Ord. No. 31 of 5/24/65, Sec. 11-3*

> "No person shall willfully or negligently deposit or throw from any vehicle or place upon or along side any highway, street, alley or easement used by the public for public travel any debris, paper, litter . . . trash or garbage, . . . or other waste substances." *Code, Sec. 20*

> "No person shall, for any cause or purpose, deposit, throw or scatter or permit or allow the accumulation of refuse, litter, rubbish, or waste material, in, upon or along any street, alley, bridge, sidewalk, or in any gutter of any street in the city . . . " *Code, Page 104*

Extension of the prohibitions to all "public grounds" is exemplified in the ordinances of Bowdle, South Dakota, and Wauwatosa, Wisconsin, respectively providing that:

> "It shall be unlawful . . . to throw or deposit in any of the streets, avenues, alleys or public grounds . . . any offal, . . . manure, garbage . . . tin cans or any matter or materials offensive to the public . . . " *Code, Chap. 6, Sec. 8*

> "It is hereby made unlawful . . . to place, throw, or leave any slops, dirty water, or other liquid of offensive smell . . . or other nauseous or unwholesome matter or substance, or any rubbish, asher, paper, dirt, stones, bricks, manure, tin cans, boxes, barrels, or other substances whatsoever . . . or to drain or pour, or to permit to drain or flow, oil, kerosene, benzine, or other similar oil or oily substance or liquid, in or upon any sidewalk, street, alley, or other public place, park or ground, within the City . . ." *Code, Sec. 5.11 (1)*

It will be noted that the last-quoted ordinance includes references to *liquids* within its provisions. An ordinance specifically directed to fluid matter is the following of Decatur, Georgia, which asserts that:

> " . . . it shall be unlawful . . . to allow waste water from washing cars or from other sources to run across the sidewalk, . . . for any person to use the streets or sidewalks or gutters as a means of drainage to carry off any used and dirty water or . . . to throw or discharge from any lot or building any water, fluid or liquid substance so as to make it unsafe for travel." *Ordinance of 6/3/58, Secs. 1-4*

Beaches and Environs

To control disposition of refuse in and about its famous beach, the City of Daytona Beach, Florida, provides that "It is unlawful to dispose of or discard any trash, garbage, bottles, cans or other refuse in or upon the Atlantic Ocean beach within the corporate limits of the city." *(Code, Sec. 17-4)*, and also stipulates that:

> "(1) Any person or persons operating a private business or concession on or adjacent to the Broadwalk or the Atlantic Ocean beach shall be prohibited from placing any garbage or trash resulting from the operation of said business or concession in containers provided by the city for use of the general public unless they shall have secured the written approval of the city. (2) If necessary, the city shall designate points on public property at which such refuse may be deposited or collected, and nothing in subsection (1) shall be held to prohibit the city from designating a reasonable charge or fee for the use of such public facilities. (3) The city may suspend or revoke the occupational license of any business or party violating the terms of this section." *Code, Sec. 17-6*

Catch Basins and Sewers

The too-direct disposal of wastes is proscribed in Cranston, Rhode Island, and St. Paul, Minnesota, which respectively provide that:

> "No person shall place or deposit in any street opening to any sewer or in any catch basin any animal or vegetable matter, solid or liquid, nor any filthy substance." *Code, Sec. 11-16*
>
> "No butcher's offal or garbage, dead animals, kitchen slops or any substance or obstruction of any kind whatever shall be placed, thrown or deposited in any catch basin, and no person shall obstruct the mouth of any sewer or drain." *Code, Sec. 230.20*

Waterways

Despite this study's overall concern with indirect or derivative water pollution, some attention may be paid to that occurring as a result of direct or original actions. These have been sought to be controlled by various cities, in respect to their waterways or drainage courses, by such language as is used (with emphasis supplied) in the following ordinances, respectively, or Honolulu, Denver, Reno, Nevada, West Memphis, Arkansas, and Council Bluffs, Iowa:

> "It shall be unlawful for any person to dump or dispose of refuse into *any watercourse or drainage facility*, whether publicly or privately owned . . . " *Code, Sec. 9-3.9 (d)*
>
> "No person shall throw, place, or deposit . . . any dung, carrion, dead animal, offal, garbage, or any putrid or offensive substance . . . upon the margin or banks or into the waters of *any lake, reservoir, ditch, creek or river* . . . No dung, carrion, dead animal, offal, or putrid or offensive substance . . . shall be thrown, placed or deposited upon any street, alley, public or private ground, *the natural drainage or flow of the surface waters of which* is into any river creek, reservoir, lake or other body of water . . . " *Code, Sec. 862.5*
>
> "It shall be unlawful for . . . any person having the management or control of . . . *any ditch, canal or water way running through the city* to permit the accumulation or depositing therein of any driftwood, rubbish, offal, filth or other matter or substance tending to make the waters therein impure, unwholesome or offensive . . . " *Code, Sec. 11.48.020*
>
> "It shall be unlawful . . . to throw, discharge, dump, deposit or otherwise leave in *any ditch or stream within the city limits*, any substance . . . including, but not limited to, bottles, broken glass, ashes, paper,, boxes, cans, dirt, rubbish, waste, garbage, refuse, or other trash." *Ord. No. 488 of 12/16/65, Sec. 1*
>
> "Throwing or putting any ashes, dirt, rubbish or other substance in *any ditch, gutter or watercourse* . . . is declared a misdemeanor . . . " *Code, Sec. 8.50.050*

Such prohibitions often incorporate the names of local rivers, etc.; the following, of Flint, Michigan, Plaquemine, Louisiana, and Grand Forks, North Dakota (with emphasis supplied), are typical:

> "No person or persons, firm or corporation shall . . . place, deposit, throw, or empty . . . into the waters of the Flint River or any other stream or streams . . . any dead carcass or any decaying animal, vegetable or mineral matter, or any waste, oil, coal tar, or sawdust, or any chemical refuse or any industrial waste, or any straw, hay, green boughs, manure, cord wood, vegetables, excrement, bones, horns, shells, meats, hides, offal, rubbish, garbage or any other substance of any unwholesome, unsightly, malodorous, contaminating, polluting or obnoxious nature." *Code, Sec. 20.9*

> "It shall be unlawful for any person to drain or permit to be drained, or to dispose of in any other manner, oil or other waste matter, which may tend to pollute fresh water, into *Bayou Plaquemine or any navigable stream which runs through, within or at the corporate limits* . . . This will include drainage into storm sewers or other drainage outlets *which drain into or toward* said stream or streams." *Code, Sec. 7-10*

> "No person, firm or corporation shall dump or place any . . . refuse, garbage, rubbish or any materials *along or on the west bank of the Red River of the North* . . . nor shall any person throw or deposit same *in the Red River of the North*." *Code, Sec. 13-0605*

Inclusion of the appurtenances of waterways with other "public places" is typified by the following ordinances (emphasis supplied) of Dayton, Ohio, Owensboro, Kentucky and San Francisco, California:

> " . . . it shall be unlawful . . . to throw, cast, or dump . . . any earth, dirt . . . rubbish, or any other material whatsoever, in or upon any street, lane, alley, avenue, *river bank*, *levee*, or any other public place . . . without first having obtained the consent of the City Commission . . . " *Code, Sec. 460*

> "It shall be unlawful . . . to throw upon or deposit in or upon . . . any of the streets, alleys, sidewalks, pavements *or wharves* . . . any trash, . . . dirt, slop, wood, waste paper, rags, . . . brush, filth or any other substance whatever . . . " *Code, Sec. 13-101*

> "No person, company or corporation shall deposit, dump or cause to be dumped or deposited upon any street, lot or lands . . . *or in any water or waterways* . . . *or from any wharf or bulkhead on the waterfront* . . . any house refuse, butchers' offal, garbage, refuse, dirt . . . rubbish or other like matter . . . " *Health Code, Sec. 280*

Private Properties

Private properties are included in the proscription of unauthorized dumping set forth (with emphasis supplied) in such ordinances as those of Jacksonville, Florida, Portland, Oregon, and Mobile, Alabama, which follows:

> "It shall be unlawful . . . to deposit, throw or place any garbage, trash, weeds, filth or waste material of any kind, or any animal or vegetable matter whatsoever on any street, sidewalk, water course, city park, *vacant lot or private premises of another*, in the city . . . " *Code, Sec. 21-12*

> "It shall be unlawful for any person to deposit or allow to remain any . . . garbage . . . or any rubbish of any kind or nature upon any public *or private* premises or places of any kind or nature or in any standing water, waterway, river, excavation, basement, or any similar places within the city . . . " *Health and Sanitation Code, Sec. 18-1702*

> "It shall be unlawful for any person to drop, dump, throw, or place any garbage . . . rubbish, trash . . . or material of like kind or any other debris upon any public street or right-of-way or into or along any ditch, drain, or drainage easement *or upon any private property, without the consent of the owner thereof* . . . " *Code, Sec. 23-24*

Sweeping onto Sidewalks, etc.

Akin to unauthorized dumping would be unauthorized sweeping of refuse into public ways—practices which are outlawed by such ordinances as the following of Shelby, North Carolina, Wichita, Kansas, St. Paul, Minnesota, and Ketchikan, Alaska:

> "No person shall deposit in or sweep into any street, sidewalk, gutter, public square, park or lot in the city any garbage, trash, rubbish, dirt, broken glass, tin cans, fruit peelings, refuse, or ashes, waste, or loose paper." *Code, Sec. 8-13*

> "The raking, sweeping or otherwise moving of leaves, dirt, paper and other debris into the gutters or drainage ditches along the sides of any street or alley in the city, without removing the same immediately thereafter, is hereby declared to be a misdemeanor." *Code, Sec. 10.04.030*

> "No person shall throw or deposit or permit to be thrown or deposited, any snow, ice, dirt, paper, filth, or the sweepings of any house, store, shop office or any other material on or into any street, sidewalk, lane, alley or public ground. No person shall sweep, push or in any manner whatsoever deposit any sweepings of the interior of any house, store, shop or office onto the public sidewalk fronting said premises, or into the street, alley or lane abutting said walk of premises." *Code, Sec. 209.02*

> "It is unlawful for any person, firm, or corporation to deposit, throw or sweep into or upon the streets, alleys, parking, or sidewalks of the city any paper, rubbish, grass, weeds, tree trimmings, dirt, trash, crates, boxes, or other refuse of any kind." *Code, Sec. 18.6*

Designation of Dumping Areas

Some cities ban dumping except in particular areas designated for the purpose; typical provisions are the following (emphasis supplied) from the ordinances of Milford, Delaware, South Bend, Indiana, Cranston, Rhode Island, and Denver, Colorado:

> "No person shall throw into or deposit dirt, rubish, garbage or filth . . . anywhere within the limits of the City . . . *except in such place or places as may be designated for that purpose by the City Council." Code, Sec. 337 (a)*
>
> "It shall be unlawful . . . to dump any garbage or household rubbish or trash of any type, kind or nature, within the city limits . . . *except in such areas as are designated . . . as land-fill areas* . . . " *Code, Chap. 11A, Sec. 7*
>
> "It shall be unlawful for any person to throw or deposit . . . any decomposable organic matter . . . or any combustible material . . . upon any vacant lane in the city, *unless such land shall have previously been designated by the director of public health as a proper and suitable place for such use." Ord. No. 31 of 3/24/65, Sec. 11-1*
>
> "It shall be unlawful . . . in disposing of or removing any rubbish or other waste matter, to litter, deposit or cause to be deposited on any premises other than those designated as official city dumps . . ." *Code, Sec. 352.8-1*

Permission and/or Permit Required

Dumping on public or private property often specifically requires the owner's permission, sometimes additionally to formal site designation. Even when the owner of private property consents, a permit from the city may also be required. The various approaches are illustrated by the following excerpts (emphasis supplied) from ordinances of Twin Falls, Idaho, Modesta, California, Des Moines, Iowa, and Minneapolis, Minnesota:

> "No person shall willfully or negligently deposit upon any public or private property . . . any debris, paper, litter . . . trash, garbage, lighted materials or other waste substances on any place not *authorized by the state, county, city or the owner of the private property." Code, Sec. 21*
>
> ". . . it shall be unlawful for any person to . . . dump upon any of the public . . . ways or parks of the City . . . without *first obtaining the consent in writing from the Director of Public Works* . . . or . . . upon any lots or property owned by any other person within the City . . . without *first obtaining the written consent of the owner or legal occupant of such property." Code, Secs. 5-5.31 and 5-5.32*
>
> "It shall be unlawful to dump garbage . . . on *any* street, alley or private property; and to dump rags, bottles, liquid waste, tin cans or excessive amounts of manure, leaves, grass or brush on any *privately owned property* without the *consent of the owner and the city*; and to dump cinders, ashes or dirt on any street, alley or public ground without the *consent of the city." Code, Sec. 22-7*
>
> "The owner, agent, lessee or occupant of any private property may fill in or deposit upon property owned, leased, managed or occupied by him, ashes or other substances which are free from dead animals or vegetable matter and other unwholesome or putrid substances or materials, and such substances may be placed or deposited upon any vacant lot or premises by a person *other than* the owner, agent, lessee or occupant thereof if such person has *first secured the consent of such owner, agent, lessee or occupant* so to do and has *also first secured a permit therefor from the City Engineer." Code, Sec. 770.020*

Residence Requirement

Among the many ordinances reviewed in the course of this study, one was noted to restrict dumping privileges to residents and businesses within the city and prohibit "importation" of solid wastes. Other jurisdictions where adequacy of disposal facilities poses a grievous problem may be interested in the pertinent provisions (excluding the penalty, severability and emergency sections) of the Oak Ridge, Tennessee, ordinance:

> "No person who is a non-resident of the City . . . or who does not operate an established place of business in the City shall deposit any garbage, rubbish, or waste of any kind upon the grounds designated by the City as a City Sanitary Landfill or upon any other ground, street, or place inside the City; nor shall any such person go upon such grounds for the purpose of depositing thereon any garbage, rubbish, or waste. No person who is a non-resident . . . shall transport into or cause to be transported into the City . . . any garbage, rubbish, or other waste of any kind for the purpose of depositing such garbage, rubbish, or waste upon any ground, street, or place within the City." *Ord. No. 54-60, Secs. 1 and 2*

Residents of Scottsdale and Mesa, Arizona, must present authorized identification cards when "hauling refuse from their homes in private vehicles no larger than a pickup truck (½-ton capacity)" for free disposal (for which the proper city pays, however) at a sanitary landfill established, by agreement, on an adjoining Indian Reservation. Persons not residents of either city or the reservation may use the facility, however, upon paying (minimum 50c) at the rate of 50c per cubic yard, though the Tribe may apply to them a limitation that "shall not be exercised in an unreasonable manner."

Licensing Dumps

Except as provided in its garbage collection ordinances the City of Flint, Michigan, makes it "unlawful for any person . . . to dump, deposit, or drop on any premises . . . any tin cans, rubbish, refuse or other waste products unless the same is placed upon some dumping ground licensed as hereinafter provided" *(Code, Sec. 28.2)*—and also "unlawful for any person . . . to maintain or operate a dumping ground . . . unless such person . . . shall have obtained a license to maintain and operate such dumping ground . . ." *(Code, Sec. 28.4)*.

The license application shall indicate the name of the applicant, who will be in charge, what area is to be used, what waste products will be received and from whence, and the hours and type of operation. Prior to its approval by the city governing body it must receive approving endorsements by the health, fire, and public works departments and the applicant "shall have demonstrated . . . his familiarity with the terms of this ordinance and his ability to maintain and operate a dumping ground in strict conformity with the terms of this ordinance" *(Code, Sec. 28.5 (b) 4)*. The annual license fee is $50, and a $200 deposit must be paid and maintained to reimburse the city for fire calls (at $50 each) necessitated and for any resultant damage to fire hose or equipment.

San Francisco's regulation of dumps requires each operator to obtain and have annually renewed, a "conditional use" (revocable) permit from the Department of Public Works. Landfill is the only allowable disposal method. Fees for the original and renewal applications are $100 and $25, respectively—they are to cover the cost of investigation, review, and (if it occurs) issuance, and are not refundable even if the permit or renewal is denied. The application must identify the applicant, locate and briefly describe the dump site, include two copies of a detailed site map drawn to scale and "such other appropriate information as the director (of public works) may require" *(Public Works Code, Sec. 853)*.

Site Cleanliness

Under a new Michigan law (Act 87 of 1965) the state's department of public health has promulgated "Regulations Governing Solid Waste Disposal Areas" (Filed 11/23/65; Supp. No. 45 to 1954 Administrative Code) which establish sanitary standards for all kinds of disposal procedures. With reference to dumps, landfill, and hog feeding, respectively, they provide that:

> "Open dumps shall not be permitted unless the location and specific method of operation has been approved in writing . . . and provided further that the isolation and operation and maintenance does not constitute a nuisance or hazard to health." *R 325.1106*
>
> "Measures shall be provided to control dust and blowing paper. The entire area shall be kept clean and orderly." *R 325.1105 (4)*
>
> "(1) Garbage . . . when fed to hogs shall be fed on a readily cleanable impervious feeding area. (2) The general area including cooking facilities, when provided, shall be kept in a sanitary manner to prevent the attraction, harborage and breeding of insects and rodents and shall not create a nuisance. (3) All residues resulting from the day's feeding operation shall be disposed of by a method approved by the health department having jurisdiction." *R 325.1107*

In relation to central garbage grinders and incinerators ("refuse burners") the Michigan rules provide that "The general sanitation in and around the (facility) as well as the operational procedures employed shall be subject to the approval of the health department." *R 325.1108 and .1109*

The aforementioned "licensing" cities—Flint and San Francisco—incorporate site cleanliness requirements inio their ordinances, respectively as follows:

> "Every person licensed hereunder shall so operate and maintain said dumping ground as to prevent any material which may be thereon from being blown about by the wind on to streets, alleys or other public places or upon private property of any other person." *Code, Sec. 28.7*
>
> "Dumps shall be enclosed by fences not less than six feet high and adequate to prevent unauthorized dumping and to prevent the blowing of rubbish from the dump. . . . Dust shall not be permitted to blow from a dump to adjacent properties and the permittee shall by sprinkling with water or other means prevent such blowing of dust." *Public Works Code, Secs. 856, 857*

CLEANLINESS OF PRIVATE PROPERTY

Requirements that private properties be maintained in a neat and sanitary condition take a variety of forms in numerous cities. A few of these are exemplified in excerpts from the pertinent ordinances of Prichard, Alaska, Daytona Beach, Florida, Sandusky, Ohio, and Fargo, North Dakota, which follow:

> "It shall be unlawful . . . to maintain any lot or yard or premises in an unsanitary condition . . ." *Code, Sec. 93 (36) (8)*

> "All lots and yards shall be kept clean and neat by the owner of the premises, and material shall not be permitted to be kept at any time which will be deemed unsanitary . . ." *Code, Sec. 17-2*

> "No person owning, occupying, or otherwise having charge of or control of any property shall place or permit to be placed on such property any paper, dirt, ashes, cartons, boxes, or any scrap or waste materials, so that such matter or materials could be blown onto any street, sidewalk, alley, park, public ground, or property of another." *Code, Sec. 37.4*

> "No person shall permit to accumulate in or about any yard, lot, or premises, or upon any street or sidewalk adjacent to or abutting upon any lot, block, or primises, owned or occupied by him or for which he may be agent, within the city limits, any manure, ashes, rubbish, or other foreign matter which is detrimental to the cleanliness of the city or the health and safety of its residents." *Code, Sec. 11-0801*

Dwellings Specifically

Focussing on residential cleanliness particularly are such ordinances as those of Rockville, Maryland, and Bettendorf, Iowa, whose pertinent provisions assert that:

> "Every dwelling within the City . . . shall be kept so clean and free from any accumulation of dirt, filth, rubbish, garbage or similar matter as not to be a danger to the health of any occupant thereof, and shall be kept free from vermin and rodent infestation. All yards, lawns and vacant lots shall be similar kept clean . . ." *Code, Sec. 10-1.01*

> ". . . The owner of every dwelling, and in the case of a private dwelling the occupant thereof, shall thoroughly cleanse or cause to be cleansed all the rooms, passages, stairs, floors, windows, doors, walls, ceilings, privies, water-closets, cesspools, drains, halls, cellars, roofs, and all other parts of the dwelling, or part of the dwelling of which he is the owner or in case of a private dwelling the occupant . . ." *Code, Sec. 25.38*

In numerous cities the requirement of cleanliness of private land and buildings is extended beyond property lines, most usually to include adjoining sidewalks. Some take a negative approach, as in Jackson, Mississippi, for business properties, and in Weirton, West Virginia, for all, thus:

> "It shall be unlawful . . . to fail to keep the sidewalks and gutters in front of one's place of business clear and free from all trash, dirt, slush or slops, and any or all obstructions whatsoever." *Code, Sec. 1023*

> "It shall be unlawful for the owner of any lot in the city, or the agent in charge thereof, to permit the accumulation of leaves, waste paper or other litter on the sidewalks in front of or abutting upon such property for a period of more than twenty-four hours . . ." *Code, Sec. 23-14*

Others take a positive approach by imposing a definite obligation, as in the following applicable ordinances (with emphasis supplied) of Honolulu, Phoenix, Arizona, and Council Bluff, Iowa, thus:

> "After the establishment of the grades of streets . . . every property owner whose land abuts or adjoins such streets *shall continuously maintain and keep clean* passable and free from weeds and noxious growths, the sidewalk area which abuts or adjoins his property. The term 'sidewalk' as used herein shall mean that portion of a street between a curb line, or the lateral line of a roadway, and the adjacent property line intended for the use of pedestrians, including any set-back area acquired . . . for road widening purposes." *Code, Sec. 20-5.2*

> "All persons owning or occupying any building, grounds, or premises within the city *are hereby required* to remove from the same and all sidewalks adjacent thereto all dirt piles, debris, rubbish, garbage, weeds, and brush and to keep and maintain the same free and clear of all dirt piles, debris, rubbish, garbage, weeds, and brush." *Code, Sec. 27-66(a)*

> "When any such waste . . . shall have been deposited in front of any building or lot . . . the same *shall be removed* by the owner or tenant of said property in possession of said premises and *it shall be the duty* of such persons to remove any dirt, earth, ashes, garbage, sweepings, manure or other refuse that may be found upon said streets or sidewalks or in the gutters thereof from in front of the said premises, and to keep the said sidewalks clean and free from dirt, litter and refuse matter." *Code, Sec. 8.50.030*

Responsibilities placed upon property owners to an appreciable distance from their property lines go as far as the Owensboro, Kentucky, assertion that "It shall be the duty of all persons to keep well cleaned out the streets and gutters for four feet out from the pavement curbing so far as the property occupied by them respectively fronts or binds on any street . . ." *(Code, Sec. 13-99)*. Requiring care in the "parking strip" seems more usual, however, as to which the following ordinances (with emphasis supplied) of Seattle, Washington, and Newport News, Virginia, are illustrative:

> "It shall be unlawful to allow the accumulation of litter on sidewalks *or planting strips (parking strips)* by the owner or occupant of abutting private property, whether such litter is deposited by such owner or occupant or not." *Ord. No. 89021 of 2/24/60, Sec. 6*
>
> "It shall be unlawful for the occupant, owner, the beneficiary of any easement or other right of use, or any person in possession or one having charge . . . of any real property within the City, *including the area adjoining such property extending to the curb line*, to permit the accumulation of any grass, weeds, . . . debris, litter or rubbish, on such property within 100 feet of any dwelling or structure, whenever such . . . are in any way detrimental . . ." *Code, Sec. 21-21*

Inspection

To facilitate detection and elimination of objectionable conditions some cities empower existing inspectors, or create new ones, to view properties and perform specified corrective functions. Utilizing pre-existing positions, Little Rock, Arkansas, provides that:

> "Inspectors employed by the health department and/or the sanitation department of the city shall make regular inspections of all premises, alleys, and vacant lots and/or properties in the city and shall have the power to notify the owner or owners thereof of any unsanitary conditions existing thereon. Within ten days . . . if such owner or owners do not . . . the inspectors . . . shall be authorized to immediately correct such unsanitary condition . . ." *Code, Sec. 15-9*

Brigham, Utah, on the other hand, created a new position in the course of enacting a 1966 ordinance:

> ". . . to establish a means whereby this municipality may remove or abate or cause the removal or abatement of injurious and noxious weeds and of garbage, refuse or unsightly or deleterious objects or structures pursuant to the powers granted to it by chapter 11 of title 10, Utah Code Annotated, 1953, as amended, and pursuant to its general power to abate nuisances." and declared that "the above listed weeds, objects and structures shall constitute a nuisance when they create a fire hazard, a source of contamination or pollution of water, air, or property, a danger to health, a breeding place or habitation for insects or rodents or other forms of life deleterious to human habitations and are unsightly or deleterious to their surroundings." *Code, Sec. 24-14.A*

The new position came into being via the stipulation that:

> "The office of inspector is hereby created for the purpose of administering the provisions of this section and the powers delegated to this municipality by such statutes subject to such control and review as the city council may from time to time direct. . . . The city council may appoint such assistant inspectors and delegate to them such powers and duties as it may from time to time determine by resolution. The powers and duties of the assistants shall be the same as those of the inspector, unless otherwise so specified by resolution." *Code, Sec. 24-14.B*

The powers, duties, and responsibilities of the position are set forth in broad but explicit terms as follows:

> "The inspector is hereby authorized and directed to inspect and examine real property situated within the municipality for the purpose of determining whether or not it contains injurious or noxious weeds, garbage, refuse or unsightly or deleterious objects or structures, and for the purpose of determining whether or not the existence of such weeds or objects creates a fire hazard or constitutes a source of contamination or other danger to health and safety, or otherwise creates nuisances, as above declared. If the inspector concludes that such conditions exist in whole or in part, he shall: (a) Ascertain the names of the owners and occupants and descriptions of the premises where such objects and conditions exist. (b) Serve notice in writing upon the owner and occupant of such land, either personally or by mailing . . . requiring such owner or occupant . . . to eradicate or destroy and remove the same within . . . ten days from the date of service of such notice. (c) Inform the owner or occupant . . . that in the event he disagrees . . . and does not wish to remove such objects or objectionable conditions, he may request in writing a hearing before the governing body . . ." *Code, Sec. 24-14.C*

Abatement

Enforcement of requirements for sanitation of private properties, or the "abatement" of unsatisfactory conditions, follow generally well established procedures in relatively similar patterns, so a few excerpted examples should suffice. Continuing with the Brigham, Utah approach, it is subsequently provided that:

> "At the written request of an owner or occupant . . . the governing body shall conduct an informal hearing . . . Thereafter within not more than ten days the governing body shall . . . render its written decision . . . In the event the decision . . . upholds the determination of the inspector, the notice originally given . . . shall . . . be sufficient to require the owner or occupant to remove or

> abate such objects or conditions and he shall have up to ten days . . . within which to conform thereto. . . . In the event . . . the governing body either overrules or modifies the determination of the inspector, the written decision . . . shall apprise him of that fact and set forth the details and extent to which the owner or occupant must make removal or other abatement . . . if any. . . .within ten days after service of mailing of a copy of such decision . . . If any owner or occupant . . . shall fail or neglect to conform to the requirements . . . the inspector shall mail a copy thereof to the owner or occupant, or both, demanding payment within twenty days . . . In the event the owner or occupant fails to make payment . . . the inspector either may cause suit to be brought . . . or may refer the matter to the county treasurer . . . In the event that the inspector elects to refer the expenses . . . to the county treasurer for inclusion in the tax notice of the property owner, he shall make in triplicate an itemized statement . . . to the county treasurer within ten days after the completion of the work . . ." *Code, Sec. 24-14.E-J*

The gist of provisions of three other cities—Salina, Kansas, Pine Bluff, Arkansas, and Scottsdale, Arizona,—excerpted for brevity, follow as additionally illustrative:

> "Whenever the health officer of the city shall determine that a nuisance or unhealthful condition . . . is detrimental to the health of the inhabitants . . . then the health officer shall forthwith issue notice requiring the owner . . . of the premises . . . to remove and abate . . . the thing or things therein described . . . within ten (10) days . . . If such owner or agent shall fail or neglect to comply . . . then the city manager shall have the thing or things . . . removed and abated . . . and the cost . . . shall be assessed . . . against the lot . . . on which nuisance was located; . . . and it shall be collected by the county treasurer and paid to the city as other taxes are collected and paid. The health officer shall adopt all necessary measures for . . . cleansing and abating of all nuisances . . . and he may do or cause to be done whatsoever in his judgment shall be necessary to carry out such measures. The health officer shall, in all cases . . . necessary for the speedy execution of his orders, cause any unhealthful condition or nuisance . . . to be abated or removed at the expense of the city; . . . The said officer shall certify . . . the cost . . . and such amount shall be assessed upon such property . . . to be collected as other special assessments. *Code, Secs. 15-3 - 15-5*
>
> "If the owner of any . . . real property . . . shall neglect or refuse to remove, abate, or eliminate any such condition . . . after . . . ten (10) days' notice in writing . . . the Housing Inspector or other authority . . . is authorized to do whatever may be necessary to correct said condition and to charge the cost thereof to the owner . . . and the city shall have a lien against such property for said cost. . . . In fixing the cost . . . (he) . . . shall keep a careful record of the cost to the city of doing said work, . . . which shall be considered the base cost, plus a charge of twenty percent (20%) of said base cost . . . to cover administrative, clerical, office and supervisory expenses, all of which, collectively, shall be considered the total cost. In no event shall any single . . . parcel of land be assessed . . . less than five dollars . . . the City Collector . . . shall . . . record same . . . and give notice that the City . . . claims a lien against the property . . . When the total cost . . . shall have been paid, the City Collector . . . shall . . . release said lien . . ." *Ord. No. 4004 of 7/18/66, Sec. 2*
>
> When any owner or occupant of any . . . premises within the City . . . fails, neglects, or refuses, for more than thirty (30) days from . . . notice, to remove . . . all dirt piles, debris, rubbish, garbage, weeds, and brush, the City Manager is . . . directed to remove and dispose of any and all such . . . at the expense of such owner or occupant. The City Manager is . . . to prepare a varified . . . account of all the expenses incurred . . . and file such . . . account with the County Assessor . . . All such expenses . . . are hereby declared as a tax lien . . . and shall be collected . . . as other city taxes are collected . . . Every owner or occupant . . . who shall fail, neglect, or refuse . . . shall also be guilty of a misdemeanor." *Ord. No. 162 of 10/16/62, Secs. 3-5*

EROSION CONTROL

An important aspect of excavation and grading regulation is the avoidance or control of erosion. In its regulation of removal of soil, sand and gravel, Duluth, Minnesota, indicates that "dust pallatives when deemed necessary" may be administratively required—*Code, Sec. 50-47(9.6)*—and specifically requires that:

> "The proposed excavation, removal or processing shall not result in the creation of any hazardous sharp pits, steep banks, soil erosion, drainage or sewerage problems or other conditions which would ultimately impair the use of the property in accordance with the general purpose and intent of the zoning regulation for that district." *Code, Sec. 50-47(9.3)*

Erosion control figures in the grading regulatory ordinance of Honolulu, which requires that:

> "Adequate provisions shall be made to prevent any surface waters from damaging the cut face of an excavation or the sloping surface of a fill. . . . The Chief Engineer may require such drainage

> structures or piping to be constructed or installed which, in his opinion, are necessary to prevent erosion damage and to satisfactorily carry off surface waters." *Ord. No. 1614 of 10/24/57, Sec. 14*

The requirements at Akron, Ohio, are that:

> "After the grading operations are completed . . . surface drainage facilities shall be created which will accumulate and channel all rainfall runoff into proper drainage courses . . . This shall be done in such a manner that flooding, erosion, and washing of sediment upon adjoining areas will be avoided. No silt, sand or other sediment shall be carried to public streets or sewers. Where necessary to prevent erosion, planting will be required, as approved by the Planning Director." *Code, Sec. 1974.07(b)*

Contractors on *construction projects* in St. Paul, Minnesota, are made cognizant of erosion by the requirement that:

> "Contractors shall maintain . . . public places adjacent to construction, demolition or building sites free from dust, litter, or other matter originating from their construction, demolition or building sites, including that effected by erosion and landslides." *Ord. No. 12524, Sec. 3*

Drifting Dirt

In San Francisco sand and dirt drifting or being blown is officially ". . . declared to be a menace to persons, property and/or vehicular traffic and a public nuisance" *(Public Works Code, Sec. 727)* and it is provided that:

> "Whenever sand or dirt is found to be drifting or blowing upon any street, sidewalk, or the improved private property of any community, neighborhood or considerable portion thereof, . . . the Director of Public Works shall cause a survey to be made of surrounding property to determine the immediate source of such sand or dirt and what preventative measures should be taken . . . The Board of Supervisors may then, by resolution, declare such blowing or drifting sand or dirt to be a public nuisance and said resolution shall . . . describe the property from which said sand or dirt is blowing or has blown or drifted . . ." *Public Works Code, Sec. 728*

Quarries in Honolulu are governed by the following, among other regulations,

> "The emissipn of process dust, either from the area of operations or from the excavated materials themselves, shall be minimized by frequent watering or by such other means as the Chief Engineer or his representative shall direct." *Code, Sec. 13-16.2(4)(a)(2)*

GRADING

Grading and related operations are customarily regulated by issuance of permits, to which specific conditions may be attached. As examples, Richmond, California, includes two conditions particularly pertinent to our interest—"Cleaning up area and planting in accordance with approved grading plans" and "Reasonable provisions for controlling excessive dust" *(Code, Sec. 12.44.090)*—and includes the following among grounds for revocation of a permit, that:

> "The applicant, in transporting materials, or operating equipment in, around, to and from the site and in connection with the grading operations for which the permit was issued, fails to operate the equipment properly on or along public road, or allows materials or litter to approach, obstruct or be deposited on pavement, or in drainage channels, or otherwise within the road right of way, to the detriment of the public road or creates a hazard on the public road; or causes unauthorized obstruction or diversion of drainage channels within the site areas." *Code, Sec. 12.44.100(a)*

Stockpiling

In connection with grading, Honolulu provisions for stockpiling fill material are of interest:

> "Any person to whom a grading permit has been issued may, with the prior approval of the Chief Engineer, stockpile earth, gravel, sand or other like substances on the premises where the work is proposed to be done for the purpose of, or as a result of, any grading, fill or excavation. The approval . . . shall be subject to the condition that the permittee shall at all times take adequate measures to control the creation of dust. The determination as to whether the control measures are adequate shall be made by the Chief Engineer. Factors to be considered in making such determination shall include . . . the type and condition to the soil, wind direction and velocity, rainfall, location of the stockpile and proximity to adjacent residence or business establishments. If the stockpiling becomes unnecessary . . . or the permit has expired, . . . the permittee shall immediately remove such materials . . . Whenever any stockpiling . . . is being done contrary to the provisions of this section, The Chief Engineer may require the permittee to suspend all work being performed by him on the premises . . ." *Code, Sec. 23-3.5*

Fill

Both filling operations and the composition of fill materials are subject to regulation, as in the following ordinances of Decatur, Georgia, and Oklahoma City, respectively:

> ". . . any and all fill dirt and/or fill material so deposited upon any property within the corporate limits . . . shall be free of glass, metal, construction debris, and organic materials . . . it shall be the responsibility of the owner of such property upon which said fill dirt and/or fill material is placed to cause same to be rough graded to 5/10 of a foot within the thirty (30) day period . . ." *Ordinance of 11/22/65*
>
> "It shall be unlawful . . . without . . . permit of the Health Department . . . to dump or deposit any . . . refuse matter, on any public or private grounds . . . for the purpose either of filling low ground or of disposing of said materials, or for any purpose whatsoever . . ." *Code, Sec. 9.10.12*

STREET EXCAVATIONS

The sanitary aspects of regulating street excavations are covered in three sections of the NIMLO model which follow, dealing with "Care of Excavated Material," "Cleanup" and "Noise, Dust and Debris" respectively:

> "All material excavated from trenches and piled adjacent to the trench or in any street shall be piled and maintained . . . so that as little inconvenience as possible is caused to those using streets and adjoining property. Where the confines of the area being excavated are too narrow . . . the City Engineer shall have the authority to require that the permittee haul the excavated material to a storage site and then rehaul it . . ." *Sec. 10-1017*
>
> "As the excavation work progresses all streets and private properties shall be thoroughly cleaned of all rubbish, excess earth, rock and other debris resulting from such work. All clean-up operations at the location of such excavation shall be accomplished at the expense of the permittee . . . From time to time . . . and in any event immediately after completion of said work, the permittee shall at his or its own expense clean up and remove all refuse and unused materials of any kind resulting from said work . . ." *Sec. 10-1020*
>
> "Each permittee shall conduct and carry out the excavation work in such manner as to avoid unnecessary inconvenience and annoyance to the general public and occupants of neighboring property. The permittee shall take appropriate measures to reduce . . . noise, dust and unsightly debris . . ." *Sec. 10-1035*

Handling Excavated Materials

Aimed more specifically at the litter potential are the Oklahoma City requirements (emphasis supplied) that:

> "In making excavations or making improvements in or to any street, sidewalk, alley, or other public grounds, all material or earth removed and new material necessary for repairs or for new work, must be handled in a manner and placed where it will cause the least possible inconvenience to the public. *In no case shall any of such material or earth be scattered over the surface of the pavement.* At all times a clear and unobstructed waterway shall be maintained along the gutter, the cross section of which shall be not less than one (1) square foot in area." *Code, Sec. 15.2.15*

Clean-up after Backfilling

Tidying up after backfilling of street excavations is briefly handled in two Texas cutues—El Paso and San Antonio—respectively as follows:

> "The permittee shall clean up and remove all surplus earth, rock and rubbish within twenty-four hours after the refill has been completed." *Code, Sec. 19-21 (c)*
>
> "Upon the expiration of the time provided in the permit . . . all surplus dirt or other material shall be hauled away and the street cleaned and placed in the same condition as it was before such excavation was made . . ." *Code, Sec. 35-43*

Of similar import are ordinance requirements of Wichita, Kansas, Fargo, North Dakota, and Peekskill, New York, respectively as follows:

> ". . . All surplus excavated material shall be removed from the location by the person making the excavation." *Code, Sec. 10.20.070*
>
> ". . . After filling the excavations, the street, alley, or sidewalk shall be left in a condition satisfactory to the city engineer. All excess dirt or rubbish must be removed immediately after completion of the work . . ." *Code, Sec. 18-0412*

> "The permittee shall clean up and remove promptly from the site of the work, upon completion thereof, all surplus excavated material and debris, and shall leave the site of the work in a neat and orderly condition. Where top soil, seeded areas or sod are disturbed in the course of the work, permittee shall restore the ground surface to a condition as good as they were previously." *Ordinance of 5/23/66, Art. I, Sec. 9*

The connection between cleanup and repaving is established by San Francisco in its stipulations that:

> "In every case the work of repaving over all trenches must be commenced immediately after said trenches are backfilled, and the work of clearing up the streets is to be considered a part of the repaving work, and shall be finished within the same time allowed in all cases for said repaving and to the satisfaction of the Department of Public Works. . . . In every case and at all times the work of removal from the streets of all obstructions, surplus materials and debris or waste matter of every description caused and accumulated by said work of opening and restoring public streets and thoroughfares, shall be kept up jointly with the work of backfilling and repaving . . . and in all cases the surface of the street shall be restored to as good a condition as it was in before the work of opening commenced." *Public Works Code, Secs. 346 and 348*

Extension of cleanup requirements to lawns, etc., is set forth by Dayton, Ohio, by the following two excerpts from its "Rules and Regulations Governing the Making of Openings in Streets, etc.":

> "Upon completion of the work, all equipment, materials . . . excavated materials and such, shall be promptly removed from the street, alley or public place. The surface of the street, sidewalk, lawns and private property shall be cleaned, leaving same in as neat, clean and usable condition as originally found. . . . Lawns damaged by the work shall be repaired to the satisfaction of the Director of Service and Buildings." *Rules and Regulations,*" *Sec. 8*

> ". . . every effort must be made to replace not only the actual disturbed area, but any adjacent area which may have been injured or destroyed by the Permittee's work. If the existing sod can be removed and is not injured thereby, it may be replaced, but any damaged sod must be replaced by new sod. Restoration will not be considered complete until restored sod shall have knitted with the sub-grade, and any maintenance necessary (such as watering), shall be considered a part of the restoration." "*Rules and Regulations,*" Sec. 6, Art. 7

Extension to excavators' vehicles is typified by ordinances of Rockville, Maryland, and San Diego, California, which respectively assert that:

> "No person engaged in excavating . . . or having charge or control of excavation . . . or who may be engaged in or have charge or control of conveying material to or from excavations . . . shall deposit, or permit to be deposited, in any manner, upon the surface of any street, alley, avenue, highway, footway, sidewalk, parking, or other public space . . . either by placing, spilling, dropping, or tracking from wheels or vehicles, or from the feet of animals, or otherwise, any earth, clay, mud, sand, gravel, or other material. If any such deposit occurs every person whose duty it is under this Section to prevent such deposit shall promptly remove the same. . . ." *Code, Sec. 12-1.17 (a)*

> "Any rock, earth, or other material which may be dropped or deposited on any public street or place from any vehicle transporting such materials from any such excavation shall be immediately removed in a manner and to an extent satisfactory to the Superintendent of Streets, at the expense of the person to whom the permit to excavate was issued." *Code, Sec. 54.20.7 (c)*

SURFACE DRAINAGE

The control of water-bourne surface impurities is the objective of such regulations as the following of Dalles City (The Dalles), Oregon:

> "(1) No person owning or controlling any real property shall permit any type of surface water from any source whatsoever to flow from the premises across or upon any sidewalk abutting such property. (2) It is hereby made the duty of each person owning or controlling real property abutting upon any sidewalk to provide a proper system of drainage so that any overflow water will not be carried across or upon any sidewalk. (3) The improper drainage of any type of surface water from any source across or upon any sidewalk is hereby declared to be a nuisance and may be abated as provided in . . . this ordinance." *Ord. No. 751 of 9/23/57, Sec. 9*

Of similar import is the Rockville, Maryland, stipulation that:

> "Owners of lots abutting upon streets, avenues, or alleys, or upon public parking or other public space . . . and which are above grade, shall protect such lots so as to prevent dirt, sand, or gravel, or any bushes, trees, or like things from falling or being washed upon the public parking in front of such lots, or upon the sidewalks, streets, or alleyways adjacent to the same." *Code, Sec. 12-1.17 (c)*

In Richmond, California, a local amendment to the Uniform Building Code prescribes that:

> "Where the existing drainage of a building site for which a building permit is issued has been disturbed or altered by the filling or excavation of ground or the placing of top soil or the erection of a building, . . . or other appurtenance on the site, the resulting rain waters collected from such structures and appurtenances, as well as any ground or surface waters, shall not be channelized or obstructed in such a manner as to spill onto any adjacent property, or that may endanger the stability of any structure, or cause the erosion of any land area, or cause the damming, backflowing or ponding of excess water on any adjacent property. Such waters shall be conducted by means of an approved drainage system to that street, alley, easement, or public way that will best conform with the design of the city drainage system or to such other water courses or storm drainage systems which dispose of such excess waters." *Code, Sec. 6.04.020 (AA)*

VEHICULAR SPILLAGE AND LITTERING

Vehicles, primarily trucks, that proceed along the streets dribbling or scattering their contens as they go are subjected to a variety of controls via ordinances of cities of all sizes throughout the country.

A "performance" type requirement is that of a New Orleans ordinance, effective in January 1967, which declares that:

> "It shall be unlawful . . . to operate . . . any vehicle . . . for the hauling of earth, waste materials, garbage, trash, or other loose materials, in such manner as to cause or permit the spillage, dropping or casting of any portion thereof upon the streets, sidewalks, or public ways . . ." *Code, Sec. 28-20(a)*

Other provisions of similar type are found in ordinances of White Plains, New York, and Wichita, Kansas,—respectively as follows:

> "No one being the owner, driver or manager of any car or other vehicle . . . shall scatter, drop or spill, or permit to be scattered, dropped or spilled, any dirt, gravel, sand, clay, loam, stone or building rubbish or hay, straw, oats, sawdust, shaving or other light materials of any sort, or manufacturing, trade or household waste, refuse rubbish or any sort, or ashes or manure, garbage or other organic refuse or other offensive matter therefrom, or permit the same to be blown off therefrom by the wind, upon any street or public place of the city." *Ord. of 6/20/49 as amended thru 10/3/55, Sec. 8*
>
> "It shall be . . . unlawful for any person transporting or hauling any rubbish or trash, garbage, waste materials produced from construction, remodeling or demolition, dirt, rock, concrete, masonry materials or salvage materials over or along the streets . . . or other public ways of the city, to scatter or spill such materials upon, or to litter the streets and public ways of the city with the same, or to permit, allow or suffer any rubbish, trash, garbage, waste materials produced from construction, remodeling or demolition, dirt, rock, concrete, masonry materials or salvage materials to be spilled or scattered, or to remain upon the streets . . . or other public ways of the city. *Code, Sec. 7.08.130*

Construction is alluded to in general language in at least three city ordinances which require that the vehicle be ". . . so constructed or loaded as to prevent its contents from dropping, sifting, leaking, or otherwise escaping therefrom . . ."—those of Fargo, North Dakota, and Bingham and Ogden, Utah. Each adds different stipulations, however, respectively as follows:

> ". . . sand may be dropped for the purpose of securing traction or water or other substance may be sprinkled on a roadway in cleaning or maintaining the roadway." *Code, Sec. 8-0909*
>
> "There shall at all times be a minimum of three inches between the top of the contents and the top of the sideboards and endgate of the vehicle." *Code, Sec. 24-20*
>
> "If necessary to prevent such littering . . . the material . . . shall be securely tied down, or shall be tightly covered with heavy canvas or other suitable covering." *Code, Sec. 14-18-26(b)*

More specific construction detail is contemplated in the Salina, Kansas prohibition against those:

> ". . . who shall haul . . . loose material, dirt, manure, trash, slop or any other material of any kind except in a vehicle having a tight box or tank so constructed to prevent the splashing or spilling of any substance therein contained upon any street, avenue or alley . . ." *Code, Sec.31.1*

Oil and Grease

A particular type of spillage—of oil and other petroleum products—receives special attention in the ordinances of several cities. Los Angeles provides simply that:

> "No person shall pour, spill or permit to drip from any tank vehicle, upon any asphalt or bituminous pavement laid upon any street, any oil, petroleum, kerosene, benzine, or other similar oil or oily substance or liquid." *Code, Sec. 62.79*

Kalamazoo, Michigan, has the same requirement as to "any" pavement and adds certain specifics in the two sections following:

> "All oil delivery wagons or tanks shall have securely fastened under the taps or faucets thereunto attached an absolutely oil or water tight zinc lined box or tray; and in filling any measure, or other vessel, must be held so that any drip or overflow shall flow into said box or tray; and in removing the same over the pavement, no drip or overflow from such measure or other vessel shall be permitted to fall upon any pavement, and no receptacle for holding oil shall be placed on the pavement . . ." *Code, Sec. PL702*
>
> "All automobiles, motorcycles, or motor vehicles shall be provided with an absolutely oil or water tight receptacle or receptacles, so placed that any drip or overflow from the machine shall fall into said receptacle or receptacles. No such receptacle shall be emptied or allowed to drip or overflow upon any pavement." *Code, Sec. PL703*

Provisions of similar import in Oakland, California, stipulate that:

> "It shall be unlawful for any person to drain or deposit upon any street, sidewalk, park or public land or into any dump, gutter, catch basin, manhole, conduit, sewer, lake or waterway . . . any tar, asphaltum, gasoline, lubricating oil, greases, waste oil from motor vehicle crank cases or any by-product of petroleum. Every motor vehicle machine or apparatus using electricity, gasoline . . . or any product of petroleum for its motive power shall have attached thereto suitable devices for . . . preventing deposits from leaks or drippings . . . and every person engaged in transporting . . . coal, oil, petroleum, distillate or gasoline, when the same is contained in tanks, must provide drip pans to be placed under the faucets of such tanks to prevent the leakage of said product upon the streets." *Code, Sec. 2-1.78*

Again, a "performance" type of restriction, but applicable only to asphalt pavement, is utilized in St. Paul, Minnesota, thus:

> "It is unlawful . . . to scatter, pour or drop upon any asphalt pavement any oil, gasoline, kerosene or other oily substance or product of coal or tar, pitch or turpentine; and all persons are forbidden from driving or conducting over any of said pavement any vehicle or receptacle containing any of said substances without having the same carefully and completely secured against any waste of any said substances or the spilling of any of the same from any part of said vehicle or receptacle." *Code, Sec. 211.01*

Garbage

Vehicles specifically for transportation of garbage must receive the approval of public health authorities in cities as far distant as Cranston, Rhode Island, and Salt Lake City, whose ordinances respectively provide that:

> "All swill and house offal shall be removed . . . in watertight covered vehicles. No vehicles shall be used for the removal . . . unless first examined and approved by the director of public health . . ." *Code, Sec. 11-14*
>
> "It shall be unlawful for any person to convey, transport or haul through or upon any of the public streets, any garbage, swill, market waste, night soil or other similar refuse except in sanitary receptacles especially constructed for that purpose, the same to be subject to the approval of the Board of Health. *Code, Sec. 18-3-21, par. 2*

Specifics as to construction and equipment of trucks transporting garbage are set forth by Des Moines, Iowa, as follows:

> ". . . the body or bed of every truck . . . shall be so constructed as to be sufficiently tight on the sides and end gate so as not to permit the contents of the truck to be dropped on the streets . . . The truck shall also be equipped with a right cover or tarpulin . . . securely fastened on the front, sides and rear of the truck body at all times when the truck is in motion, and . . . as to contain the contents within the truck and not permit blowing or spillage upon the streets or alleys." *Code, Sec. 22-12*

Refuse and Rubbish

A comprehensive regulation of non-garbage transportation is provided in the ordinance of Lewiston, Main, which sets forth that:

> "No person shall operate a vehicle upon any street in such a manner that material, rubbish, refuse, junk or litter of any kind drips, sifts, leaks, drops or otherwise escapes therefrom or drops upon the surface of such highway, street or alley and without limiting the foregoing, all open trucks carrying cotton waste, wool waste, waste paper, refuse, sawdust, wood shavings, and loose

> building salvage shall be equipped with, and use, a device suitable to prevent the latter mentioned materials from falling or being blown therefrom and littering the surface of any highway, street or alley." *Code, Sec. 510*

A "performance" type regulation is provided by the Albany, Georgia, requirement that:

> "It shall be unlawful for any person to haul or transport . . . any dirt, soil, sand, rubbish or like substance . . . in any wagon, cart, wheelbarrow or other vehicle from which such dirt, soil, sand, rubbish or like substance escapes or leaks." *Code, Sec. 29-5*

The "wheelbarrow" receives its only observed recognition in the foregoing; the "sleigh" is included among vehicles enumerated by two Michigan cities—Flint *(Code, Sec. 177.1)* and Kalamazoo *(Code, Sec. PL706).*

Coping specifically with "blowable" materials, Honolulu has ordained that:

> "No vehicle shall be driven or moved on any highway with any load consisting partially or entirely of loose paper, empty cartons, crates, or any other material susceptible of being blown or carried by the wind, unless such load is entirely covered by tarpaulin, net, canopy or other suitable material, effectively preventing any part of such load from being blown or carried by the wind; *provided, however*, this paragraph shall not apply to any vehicle carrying a load consisting entirely of soil, sand, coral or gravel, if such load is wetted down to prevent particles thereof from being blown or carried by the wind." *Traffic Code, Sec. 15-21.4(3)*

Somewhat similarly Westport, Connecticut, attacks transportation of dust-producing substances thus:

> "No dust-producing substance shall be transported . . . unless the vehicle . . . is so constructed, loaded, covered, or protected at all times as to effectually prevent the spreading or dissemination of dust . . . into the air or upon any public or private property . . . No person, firm or corporation shall operate or cause to be operated . . . any vehicle transporting sand, gravel, loam, stones, or dirt unless the said vehicle is so constructed and so loaded that the level of the load so transported at the periphy is at least two (2) inches below the level of the side boards and tail board, or the load is so covered or protected at all times as to effecutally prevent any material from said load from falling or being blown upon any public or private property . . ." *Ordinance of 4/10/57, Secs. 2 and 3*

Provisions that vehicles be "so constructed" take opposite routes to the same purpose in the ordinances (emphasis supplied) of San Francisco, California, and Greenwich, Connecticut, thus:

> "It shall be unlawful . . . to use any car, wagon or other vehicle for the purpose of transporting sand, earth or rock . . . unless such vehicle be *so constructed as to prevent* the deposit of the contents . . . in or upon any public streets . . ." *Public Works Code, Sec. 759*
>
> "No person shall . . . transport such refuse, trash, waste paper, scraps or junk through the streets in vehicles *so constructed as to permit* any part of the load toescape." *Code, Sec. 58.5*

Scavengers' Vehicles

In the course of licensing and regulating private collectors of garbage and/or refuse, cities often establish standards of construction and/or operation of the vehicles they use.

A modern vehicle *definition* is carried in the St. Paul, Minnesota, ordinance:

> "For the purpose of this ordinance, the vehicle which actually carries the rubbish or waste material is defined as follows: the word 'vehicle' shall be any trailer or semi-trailer unit of 2 cubic yard capacity or greater which is used for the hauling of rubbish or waste materials, in addition to all trucks, compactors or other vehicles which are regularly used for the hauling of rubbish or waste materials and for which a state vehicle license is required. This shall not include containers which are carried on the bed of a vehicle rather than towed as a separate unit." *Code, Sec. 321.08*

Akron, Ohio, specifies that garbage, etc., may not be transported:

> ". . . except in vehicles of the Packer type construction, barrels or other receptacles that are effectually covered and watertight . . ." *Code, Sec. 571.07*

Both the foregoing make the vehicles *subject to city inspection*—St. Paul initially by the Sanitation Bureau and Akron annually by the director of public service or his agent.

Oklahoma City also provides for vehicle inspection (by the Health Department) initially and optionally later as deemed necessary, stipulating that "upon such inspection, approval or rejection of such vehicles shall be based upon the standards herein set forth . . ." *(Code, Sec. 10.35.05)* which are established separately for garbage and trash vehicles, as follows:

> "Any vehicle whose use in such hauling is *intended for garbage*, either wet or dry, shall be of a type capable of being fully enclosed in a manner to prevent the escape therefrom of any noxious or disagreeable odors, or the escape therefrom of any noxious or disagreeable odors, or the escape of any of the contents of such vehicle. Filler openings of such vehicle shall be and remain fully closed except at the times such garbage actually is being placed in such vehicle, or being emptied therefrom. Said vehicle shall be capable of being completely emptied and cleaned." *Code, Sec. 10.35.07*

> "Any vehicle whose use is *intended for dry wastes* such as trash, rubbish, empty boxes, papers, grass and tree trimmings, cans, bottles and all similar material, may be of open body type, but shall be equipped with eye-hooks, cleats or similar hold-fast facility fixed to sides and ends of the body of said vehicle for use in lashing down the contents of said vehicle and prevent the blowing off, spilling or scattering of same along the route of haul. Equipment for such lashing down shall be appropriate to the kind of material transported, and shall consist of tarpaulin covering for loads composed of small, light-weight material reasonably susceptible of being spilled or blown." *Code, Sec. 10.35.08*

Enforcement

Provisions for recourse against those whose loads leak, spill or are otherwise deposited on the streets —beyond simple ordinance-violation penalties—have been developed by some cities. Jonesboro, Arkansas ordains that:

> "A Writ of attachment may be issued against any vehicle used in violating the provisions of this Ordinance for the collection of any fine assessed for such violation." *Ord. No. 989 of 8/3/59, Sec. III*

Two cities requiring cleanup of spilled, dropped or "wasted" matter are New Rochelle, New York, and Oklahoma City, Oklahoma—respectively providing that:

> "In addition to any penalty provided by this Ordinance any person violating . . . this section shall immediately clean or cause to be cleaned, the street or public place upon which any earth, dirt, sand, or other matter . . . has been scattered, dropped or spilled." *Code, Sec. 7.6(b)*

> "All such material or dirt wasted shall be immediately removed by either such driver or the person, firm or corporation by whom he is employed. The failure to immediately remove all of the material or earth so wasted shall render both the driver and the person, firm or corporation by whom he is employed, subject to a fine. Each day that such material or dirt so wasted, remains on such pavements shall constitute a separate and distinct offense." *Code, Sec. 9.15.13*

The pollution potential of uncleared sites following the moving or demolition of buildings is recognized in the requirement of the NIMLO model building moving ordinance that permittees must:

> "Remove all rubbish and materials and fill all excavations to existing grade at the original building site so that the premises are left in a safe and sanitary condition." *Sec. 10-207 (8)*

Two Alabama cities—Mobile *(Code, Sec. 10-13 h)* and Fairfield *(Code, Sec. 7-26 e)*—are among those enacting identical language.

Somewhat more expansive language is used in the Fresno, California, ordinance provision that:

> "It shall be the duty of any person to whom any permit is issued for the demolition or for the removal of any building, or any section or portion of any building . . . and of any person leasing, owning, occupying or controlling any lot or parcel of ground from which a building is removed or demolished to remove all weeds, concrete, stone, debris, and other loose, miscellaneous, and useless material from such lot or parcel of ground . . ." *Code, Sec. 13-217*

Moving

In Richmond, California, the terms and conditions of a house moving permit include the requirement that:

> ". . . after the said building is moved, the site from which it was moved be cleared of all loose debris and rubbish . . ." *Ord. No. 1373 of 1/7/52, Sec. 3 (k) (5)*

Hazel Park, Michigan, requires moving contractors to make a $500 cash deposit to assure compliance with several regulations, subject to subsequent check by the building inspector among them that:

> "He shall fill all excavations which result from the moving of the building and the removal of all materials and debris from the premises from which the house is to be moved, in case said premises are located within the City." *Ord. No. 283 of 8/22/60, Sec. 8*

Demolition

Among ordinance provisions relative to site clearance after demolition of a building, the greatest observed brevity characterized the requirements of Phoenix, Arizona, that:

> ". . . The material to be removed shall be properly wet down to lay dust incident to removal. All debris shall be entirely removed from the lot after demolition of any building." *Building Code, Sec. 1403*

The timing of clearance is variously scheduled in such ordinances as those of Duluth, Minnesota, Rhinelander, Wisconsin, and Wethersfield, Connecticut which follow:

> "All materials not used for filling in excavated areas shall be removed from premises as demolition work progresses. On completion of demolition, the premises shall be filled where necessary with soil, cinders or other approved inorganic material and graded to the level of the lot grade adjoining the building site . . ." *Building Code, Sec. 201 (e)(12)*
>
> "All debris, rubbish and other materials not used for fill shall be removed from the premises on completion of the demolition work, and the site graded to conform with the grade of adjoining premises. . . ." *Code, Sec. 14.10 (5)*
>
> When the work of demolition has been carried to completion, the premises shall be left free and clear of any material or debris . . ." *Building Code, Art. II (8)*

BONFIRES AND INCINERATION

The major objectives of city regulation of the burning of any materials, whether within an incinerator or outside, are related to fire prevention and air pollution control. Accordingly, identified aspects of litter control and surface cleanliness are relatively few.

Permits

To require permits for rubbish-burning or bonfires is a frequent practice. Fargo, North Dakota, and Cranston, Rhode Island, are two cities which identically provide that:

> "No person shall kindle or maintain any bonfire or rubbish fire or authorize any such fire to be kindled or maintained on or in any public street, alley, road or other public ground without a permit or other proper authorization. . . ." *Fire Prevention Code, Sec. 28.1(a)*

While the foregoing apply to "public" space, the restriction is dropped by Duluth, Minnesota, in its provision that:

> "No person shall kindle or maintain any bonfire or rubbish fire or authorize any such fire to be kindled or maintained without a permit therefor. . . ." *Code, Sec. 28.1 (a)*

At St. Paul, Minnesota, a differently phrased requirement specifically adds private premises but provides an exception (emphasis supplied), thus:

> "No person shall kindle or maintain any bonfire or shall knowingly furnish the materials for any such fire, or authorize any such fire to be kindled or maintained on or in any street, alley, road, land, or public grounds *or upon any private lot*, unless a written permit to do so shall first have been secured from the Bureau of Fire Prevention. *This shall not prohibit* the burning of inconsiderable quantities of rubbish on private premises on any day between the hours of 3:00 p.m. to 8:00 p.m. when placed and contained in a noncombustible container of any type approved by the Chief of the Bureau of Fire Prevention." *Code, Sec. 192.01*

Regulation

Among the various regulations of fire control ordinances the following of Wethersfield, Connecticut, relate to litter aspects to some extent:

> "Fires may be kindled or allowed to burn outdoors if they shall satisfy each and all the following conditions: (1) be contained in an incinerator or other receptacle sufficient to restrain the materials to be burned and resulting fly ash; (2) be thoroughly extinguished no later than 8:00 p.m., any subsequent smoldering to be considered a violation of this ordinance, and (3) be limited to any dry, readily combustible materials, excluding garbage in any form, rubber, or any material creating unreasonable smoke, odor, nuisance or other hazard to person or property. Fires outdoors which would not satisfy the foregoing requirements may be kindled or allowed to burn nevertheless, upon application to and permission granted by the Fire Marshal or his designees for

> such purpose, upon the determination of such authorizing official that the circumstances will not create unreasonable fire, smoke, odor, nuisance or other hazard to person or property." *Ordinance of 4/17/61*

Specialized Burning

Abatement of *weeds* by burning is the subject of an explicit ordinance provision of Oakland, California, that:

> "It shall be unlawful for any person to start or cause to be started any open outdoor fire for the purpose of weed and rubbish abatement, except by permission from the Fire Marshal. The Fire Marshall shall give his permission only in exceptional and extraordinary cases when all methods of weed batement other than by burning (including chemical spraying, discing, or cutting) are impractical." *Code, Sec. 2-1.761*

Burning *junked automobiles* and other scrap is regulated at San Antonio, Texas, in this manner:

> "The burning of wrecked or discarded automobiles or any parts thereof or junk or any waste materials shall be done only in designated open spaces or incinerator enclosures approved for burning purposes under special permit, issued for such action, by the fire chief. No waste burning shall be permitted and same shall be unlawful, unless special permit has been issued and is conspicuously posted on the premises, or in the office at such location." *Fire Prevention Code, Sec. 15-332*

The inclusion of *sweepings* is noted in the control ordinance of Independence, Missouri, providing that:

> "No person, firm or corporation shall burn or cause to be burned, any sweepings, trash, paper, lumber, leaves, straw, hay or any combustible material within the city limits . . . unless the same is securely confined in a refuse burner constructed of brick, concrete, plate iron, steel or wire, with all openings in said burner securely covered by a cover of screen wire. No burner shall be used with wire meshes of over one (1) inch. . . ." *Charter Ord. No. 278 of 3/25/63, Sec. 1*

Particular Locales

Bonfires on bituminous pavements are governed by an Oakland, California, provision that:

> "It shall be unlawful for any person to set fire to or burn or to cause to be set fire to or burned any rags, paper, wood, or any rubbish . . . upon any street or sidewalk paved with, or constructed of bituminous rock or any other combustible material, without first obtaining a written permit from the Superintendent of Streets." *Code, Sec. 6-2.59*

Bonfires on *any pavement* in Fresno, California, are forbidden:

> "No person shall burn a bonfire on a permanently paved street at any time." *Code, Sec. 9-1010 (b)*

Regulations of fires on *any street*, etc., in Saginaw, Michigan, are rather explicit, thus:

> "No person shall kindle fire in or upon any street, alley or other public place, except in publicly owned park ovens and except in cases where written permission has been granted by the Fire Chief, subject to such reasonable conditions and restrictions as he may determine to be necessary to protect life and property. No person shall permit a trash burner to be placed, maintained or used upon any portion of a street, alley or other public place, nor within five (5) feet thereof. In any proceeding for violation of this section, the fact of possession of the premises or of the premises abutting the street, alley or other public place where such trash burner was located, shall constitute in evidence a *prima facie* presumption that the person in possession was the person who placed, maintained or used trash burner." *Code, Sec. 304*

Only certain *roofs* are acceptable fire sites in San Diego, California, which has ordained that:

> "It shall be unlawful to build or maintain a fire on any roof, except that the provisions of this sub-section shall not apply to those buildings which have a concrete slab roof." *Code, Sec. 55.30.8 (d)*

Incineration

Outdoor moveable or "homemade" incinerators are banned by a Concord, New Hampshire, ordinance which stipulates that:

> "The use of outdoor portable incinerators, drums, barrels or other containers for the burning of trash, garbage or refuse is hereby prohibited. . . . This ordinance shall not . . . exclude the use of

> outdoor fireplaces or portable charcoal cooking devices designed and used for cooking purposes." *Code, Sec. 10.2*

On the West Coast regulation via revocable permit is established in ordinances (emphasis supplied) of the following three cities—Portland, Oregon, and Fontana and Richmond, California—thus:

> "No incinerator or other device or appliance for burning rubbish or other waste material shall be erected or used, and no enclosed fire shall be built, set or maintained outside the walls of a building without a *revocable permit* from the Fire Marshal. . . . The burning or garbage, rubber, insulation and like materials is permitted only in incinerators specifically designed for such purposes. The permits herein provided for may be revoked by the Fire Marshal if, in his opinion, conditions of incinerator use become dangerous or objectionable . . ." *Fire Code, Sec. 14-713 (a)*

> "No incinerator shall be constructed, located, installed, equipped, maintained, or used unless by virture of a permit secured from the Chief Engineer of the Fontana Fire Department, or from his duly authorized Deputy, approving the type and location of such incinerator. . . . If the location thus approved should thereafter create a public or private nuisance or fire hazard, the Chief Engineer of the Fire Department or his duly authorized Deputy *may revoke* his previous approval and the person owning or using the incinerator shall immediately cease burning therein and move the incinerator to a location approved by the Chief Engineer or his duly authorized Deputy. *Ord. No. 1316, as amended, Secs. 3 and 8*

> "No person shall operate or maintain . . . any commercial incinerator . . . without first obtaining a license so to do from the Fire Marshal . . . Wherever, in the opinion of the Fire Marshal, any incinerator is operated or maintained in a manner to create a nuisance by reason of the emission from such incinerator of smoke, fumes, noxious odors, dust, ashes or other materials, the Fire Marshal shall forthwith *cancel and withdraw* any license which may heretofore have been issued pursuant to this ordinance for the operation or maintenance of such incinerator." *Ord. No. 1316, as amended, Secs. 3 and 8*

BUILDING CONSTRUCTION MATERIALS

The litter potential of materials stored and debris accumulating at the site of building construction projects is recognized and dealt with in various ways by different cities.

Requiring a permit for any use of street space in connection with building activity is an approach taken by several cities, including at least three in Utah. The Ogden ordinance *(Code, Sec. 23-1-5)* is virtually identical with that of Brigham City:

> "It shall be unlawful for any person to occupy or use any portion of the public streets for the erection or repair of any building upon land abutting thereon, without first making application to and receiving from the council a permit for the occupation or use, for building purposes, of such portions of streets and for such periods of time and under such limitations and restrictions as may be required by the council; *provided*, that no permit shall be granted to occupy more than fifteen feet of any street, measured from the curb line, and any such permit may be revoked by the council at any time when the holder thereof fails to comply with any rule or regulation under which it is granted or when in the opinion of the council, the public good requires such revocation." *Code, Sec. 24-5*

Substantially similar language, without the *proviso*, is also used in the ordinance *(Code, Sec. 41-5-23)* of Salt Lake City.

In Minneapolis, Minnesota, the mayor is the permit issuing authority, pursuant to provisions that:

> "Any person building or repairing a building near any street, avenue, alley or public ground . . . may apply to the Mayor for a license to place building material upon such street . . . or public ground during the progress of such building or repairing . . . and the Mayor may, in his discretion . . . grant such license under such conditions and restrictions (to set forth in such license) as will in his judgment prevent needless inconveniences to the public. Such license shall be in writing and may be revoked by the Mayor at will . . ." *Code, Sec. 583.090*

Regulations to govern the accumulation and removal of rubbish and debris may be relatively brief, as in the ordinance of Des Plaines, Illinois, which follows:

> "Waste material and rubbish shall not be stored nor allowed to accumulate within the building or in the immediate vicinity, but shall be removed from the premises as rapidly as practicable. No material shall be disposed of by burning on the premises or in the immediate vicinity. Dry material or rubbish shall be wetted down, if necessary, to lay dust or prevent being blown about." *Code, Sec. 4.4-14*

St. Paul, Minnesota, has an identical provision, with one sentence inserted to require that:

> ". . . Combustible waste and rubbish shall be removed at least daily." *Legislative Code, Sec. 11.07*

Phoenix, Arizona, specifies who shall dispose of construction debris and how it shall not be handled:

> "Debris resulting from the construction, reconstruction or repair of premises shall not be placed with other refuse for collection, but shall be disposed of directly by the person owning, occupying or leasing the premises wherein such debris is accumulated. All construction debris and waste materials shall be removed promptly and shall not be stored in any location where it may be blown beyond the construction site." *Code, Sec. 22-5 (f)*

Little Rock, Arkansas, is very specific as to who is *not* responsible for removing such refuse:

> "It is distinctly provided that this chapter does not in any way obligate city employees or city trucks to clean or pick up refuse or debris resulting from construction on property where buildings are being repaired or are under construction" *Code, Sec. 15-10*

Litter Aspects Particularly

In a 1962 enactment Fargo, North Dakota, adopted a comprehensive Article on the "Littering of Public Places by Contractors" which includes the following:

> "No contractor shall allow any vehicle to operate out of any construction site, regardless of whether the same shall be operated by the contractor, his agents, employees, or subcontractors, in such a manner as to dump, scatter, or deposit any rubbish, stones, wire, earth, ashes, cinders, sawdust, hay, glass, manure, filth, paper, snow, ice, dirt, grass, leaves, twigs, shrubs, construction waste, garbage, or other offensive or nauseous material on any street, alley, or public place. The commissioner of streets shall be and hereby is empowered to order any contractor to take such precautions as he deems necessary to prevent any such foreign materials from being deposited on the street, alley, or public place and to remove all foreign material on the street, alley, or public place. If and in the event any contractor shall fail to comply with the order of the commissioner of streets, said commissioner, or the chief of police, may order all construction stopped.
>
> "No contractor or other person shall permit a vehicle to enter upon a public street, alley, sidewalk, or other public place without first (a) having its tires and wheels cleaned so as not to litter or soil any street . . . or other public place, and (b) having any material removed from the interior or exterior of vehicle body which might fall or be deposited upon any street . . . or public place by normal movement of vehicle in traveling over such places.
>
> "All streets, alleys, sidewalks, or public places adjacent to any building or construction site shall be maintained in a litter-free condition at all times. This shall include such soiling or littering caused by erosion, landslides, or general construction activities at any such site.
>
> "Whenever a contractor is engaged in any construction or maintenance activity, it shall be his responsibility to see that none of the provisions of this article are violated by himself, his agents, employees, subcontractors, or haulers of materials and supplies. If more than one contractor or any governmental unit is involved in work which contributes to the littering of streets, alleys, sidewalks, or other public places in the smae site or area, they shall be separately and jointly responsible for compliance with the provisions of this article." *Code, Secs. 11-901 - 11-904*

Transportation from construction or demolition sites in St. Paul, Minnesota, is controlled, in somewhat similar vein, by requirements that:

> "No contractor or other person shall operate or permit or cause his agents, employees or subcontractors to operate any vehicle from construction and demolition sites or from property adjacent to a street, alley, or other public place onto and upon any street . . . or other public place: (1) in such a manner or so loaded as to dump, scatter or deposit any rubbish, stones, earth, sand, gravel, filth, paper, construction waste, or any other offensive or nauseous material on any street . . . or other public place; (2) Without first having its tires and wheels cleaned so as not to litter, scatter or deposit any foreign material upon any street . . . or any public place; (3) Without having tailgates of sufficient height and closed tightly at all times while the vehicle is in operation so as to keep dirt, sand, gravel or any other material being transported from spilling, falling or being blown from the vehicle." *Ord. No. 12524, Sec. 2*

Special Activities

Mortar and concrete receive special attention inOakland, California, and Salt Lake City, Utah, respectively under requirements that:

> "It shall be unlawful for any person to place or cause to be placed anywhere upon the surface of the roadway of any public streets . . . or upon . . . any improved sidewalk . . . mortar in a moist

> state for any purpose whatsoever, or to mix or prepare the same upon such roadway or sidewalk, unless such mortar be placed, mixed or prepared in a tight box or upon a close fitted platform or bed. No moist concrete shall be allowed to stand on the surface of any street or improved sidewalk for a longer period than one hour after mixing, and on completion of the job all surplus material shall be removed and the street or sidewalk surface washed, cleaned and left in the same condition as before mixing. No rock, sand, gravel, or cement shall be washed into and left in either gutters or catch basins or allowed to find its way into catch basins." *Code, Sec. 6-2.33*

> "It shall be unlawful to place . . . any sand, gravel, lime, cement, mortar, plaster, concrete, or any other substance or mixture, or to allow the same to remain on any portion of any paved street or sidewalk . . . or to make or mix, . . . any mortar, plaster, concrete, or any other like substance or mixture on any portion of any paved street or sidewalk . . . *provided* that in cases where work is being done on buildings or pavements, the board of commissioners may grant . . . permission to mix cement, concrete or building materials in tight boxes, or on tightly joined boards, on such pavements or walk unders such restrictions as the board of commissioners may deem proper." *Code, Sec. 41-5-33*

Sandblasting is alluded to in a brief requirement of Dayton, Ohio, that "Dust, sandblasts or other harmful agents when employed or occurring in construction operations shall be disposed of at or near the point of origin to prevent their diffusion over adjoining premises or streets" *(Code, Sec. 1316.01)*. At Salina, Kansas, however, it is the subject of a special Article which defines "dry" and "wet" sandblasting, requires that a permit be obtained, and further provides that:

> "The building official shall determine whether the side of the building, adjacent buildings or other structures, vehicles, implements or other things kept or stored upon adjacent or nearby areas or vehicles parked in a street render it advisable to use wet sandblasting or whether dry sandblasting may be used and whether the precautions hereafter prescribed should be taken and issue a permit in accordance therewith. (1) *Wet sandblasting*. If wet sandblasting is required by the permit, the permittee shall use a canvas or other shield to keep the sand from splattering upon or against the property of others except by their consent. (2) *Dry sandblasting*. If dry sandblasting is permitted, a canvas or other sufficient guard shall be used to prevent sand, dust and other particles from being detrimental to or injuring adjacent property, pedestrians, sidewalks, vehicles using the streets in the vicinity of the operation, and vehicles, implements or other things kept or stored on adjacent property. (3) *Waiver*. If the building official believes that the side of the building is where the operation will not be detrimental or injurious to the property of others, he may permit the operation without the precautions herein specified. But, if after sandblasting is begun, the building official finds that the precaution being taken is not sufficient, he shall have power to order the stoppage of work until sufficient precaution is provided and used." *Code, Secs. 9-371 - 9-373*

Enforcement

Three different but sharp and decisive sanctions to enforce anti-litter regulations against those conducting construction operations are typified in these requirements, respectively, of Miami, Florida, San Francisco, California, and Fargo, North Dakota:

> ". . . applicants for building permits shall clear all rubbish, construction sheds or other materials which accumulate during and by reason of construction from the building or repair site. . . . The Building Division . . . is hereby authorized and directed to withhold the issuance of a certificate of occupancy issued under the provisions of . . . the Building Code, for noncompliance with this ordinance." *Ord. No. 4908 of 10/28/53, Secs. 1-3*

> "A deposit of . . . $30 . . . will be required for each fifty feet . . . of the lost frontage, or fraction thereof, as a guaranty that the permittee will remove all dirt, debris, materials and equipment from the street in the allotted time and restore the pavement to its original condition. If not so removed the Director, after five (5) days' notice in writing posted on the premises, may use as much of the guaranty money as is necessary for cleaning the street, removing materials and equipment, and restoring the pavement. . . ." *Public Works Code, Sec. 724.1*

> "If a street, alley, sidewalk, or public place should become soiled or littered through any of the means outlined . . . the person or persons responsible shall cause such soiling or littering to be cleaned up forthwith. If and when the person or persons responsible fail to comply with any order of the chief of police or commissioner of streets to clean up or take such precautions as the chief of police or commissioner deems necessary to prevent foreign materials from being deposited on any street, alley, or public place, then the chief of police or commissioner may order (in writing) all ingress and egress to the site or area involved stopped until compliance with the order is effected." *Code, Sec. 11-0905*

ANIMALS AND ANIMAL-CARE ESTABLISHMENTS

In relation to pollution potential of animal life in the cities the most numerous control ordinances relate to dogs—and particularly those that "commit a nuisance" in the wrong place. Cities employing the euphemism include San Francisco, Las Vegas, Nevada, and New Rochelle, New York, whose ordinances respectively provide that:

> "No person having the right and ability to prevent, shall knowingly, or carelessly or negligently, permit any dog or other animal to commit any nuisance upon any sidewalk of any public street, avenue, park, public square, or place . . ." *Health Code, Part II, Chap. V., Sec. 40(a)*
>
> "It shall be unlawful . . . to permit, either willfully or through failure to exercise due care or control, any such dog or animal to commit any nuisance upon any sidewalk of any public street or public park; or any nuisance upon any real property . . . of any other person; . . . or upon any entranceway, stairway or wall immediately abutting on a public sidewalk; . . ." *Code, Sec. 6-2-4(K)*
>
> "A person who owns, possesses or controls a dog, cat or other animal shall not permit the animal to commit a nuisance upon any paved sidewalk, upon any public premises, or upon private premises owned by another, except at the curb." *Code, Sec. 11-6.02*

Expanded in coverage (emphasis supplied) is the Richmond, California, provision that:

> "It shall be unlawful for any person . . . having charge, care, control, custody, or possession of any dog *or other animal, including fowl*, to allow or permit such dog or other animal, including fowl, to commit any nuisance upon, *or damage* the property of any other person, or upon a public street, alley or other public place." *Ord. No. 1746 of 3/12/62, Sec. 6.5*

The euphemism is discarded, in part or completely, in the ordinances of Boston, Massachusetts, Haverford, Pennsylvania, and University Heights, Ohio, respectively:

> "No person owning, keeping, harboring or having control of a dog shall permit it to foul any sidewalk of any street in the city." *Code, Chap. 29, Sec. 40A*
>
> "It shall be unlawful for the owner of any dog to permit such dog to damage or injure personal property, real estate, shrubs, hedges, flowers, or any growing thing by running over or running across the said property or by urinating thereon or defiling the same, or by causing excrement to be placed thereon." *Ord. No. 980 of 12/12/55, Sec. 7*
>
> . . . which destroys or damages any lawn, tree, shrub, plant, building or other property, . . . by scratching, digging, running, defecating, urinating or otherwise, is declared to be a nuisance. No person being the owner or in charge or control of any animal shall permit such animal to be or to create a nuisance as herein defined." *Code, Sec. 511.19*

Late in 1966 the latter city inaugurated a program to enlist the support of citizens for enforcement and their cooperation in retraining their dogs to comply and thus avoid violations. A principal feature was a bulletin of October 15 to dog owners, that set a December 1 date for beginning "rigid enforcement" of the ordinance. It requested that ". . . dog owners . . . immediately begin to train their dogs to eliminate in prepared locations in their own backyard." (as was successfully accomplished), adding that "We realize that an occasional accident will occur while you are taking your dog for a walk. In such instances you will be expected to clean up the droppings and dispose them on your own property." This is not, of course, directly required in the ordinance.

Such a "cleanup" requirement *is*, however, incorporated into a recent (4/12/65) ordinance of Evanston, Illinois, to the effect that:

> "If any dog shall commit a nuisance on any street, sidewalk, alley or public place in the city, or upon any private property, other than that of the dog owner, the owner or agent of the owner having control of said dog shall immediately abate said nuisance by cleaning the premises and removing the subject matter of the nuisance." *Code, Sec. 5-16.1*

Other Specified Animals

The keeping of *rabbits* in Oklahoma City includes . . . "any manner of keeping or raising rabbits, whether for sale, exchange, breeding, for pets or other purposes," as set forth in its ordinance, which contains the following specifics as to sanitation:

> "Only enough food shall be supplied each day for the daily needs of each rabbit. Any waste feed shall be removed each day . . . Surplus feeds shall be stored in a place . . . so constructed that the feed does not spill upon the ground or into the hutches. Each hutch must be swept and cleaned at least once every forty-eight hours and the manure and other refuse must be disposed of at least twice each week . . ." *Code, Sec. 4.2.06*

In the rabbit and *poultry* licensing ordinance of Hazel Park, Michigan, the sanitary provisions are simply that:

> "All persons keeping any rabbits or poultry shall keep the places wherein they are kept, in a clean and sanitary condition and in accordance with such rules and regulations as may be made from time to time by the Health Officer . . . Upon failure to comply with any such . . . the City Manager may revoke the permit . . ." *Ord. No. 33 of 9/14/43, Sec. 4*

Keeping *chickens* in Mobile, Alabama, requires a permit and adherance to, among others, the following conditions:

> "The chicken house and yard shall at all times be kept free from trash and accumulation of droppings. If droppings and trash obtained from cleaning the house and yard are allowed to accumulate on the premises, they shall be stored in a metal or concrete container which is provided with a tightly fitting cover . . . If garbage is fed, the remains shall be removed from the chicken house and yard daily and disposed of in the same manner as the droppings or otherwise in accordance with city ordinances. No feed of any type shall remain in a chicken house or yard, outside of a rat-proof bin, after dark or before daylight. . . ." *Code, Sec. 7-39*

Those keeping chickens and other *fowl* in Neenah, Wisconsin, must register with the Building Inspector and be governed by ordinance stipulations that:

> "All chicken coops and yards, dove cotes and other buildings or yards . . . shall be kept in a clean and sanitary manner and condition . . . and shall be subject to the inspection and approval of the Health Officer or the Street and Sanitation Committee." *Code, Sec. 10.08(2)*

Livestock

Prohibitions against "running at large"—and licensing—are principal livestock control measures so far as sanitary aspects are concerned. Examples are the following of Shelbe, North Carolina, and Hawaii County, Hawaii, respectively:

> "It shall be unlawful for any person, owning or having in his care or custody any horse, mule, cow, calf, oxen, hog, pig, sheep, lamb, goat or any other animal, to permit the same to run at large upon the streets or sidewalks or the property of another. It shall be unlawful for any person to graze or permit to be grazed any cow or other livestock upon any street or sidewalk in the city." *Code, Secs. 4-1 and 4-3*

> "No person owning, controlling or having the possession of any livestock of animals, such as cattle, horses, mules, donkeys, swine, sheep or goats, shall suffer or permit any such livestock or animal to roam, graze or stray upon any public land, highway, street, road, lane or alley . . . No person . . . shall suffer or permit any such livestock or animals to roam, graze or stray upon the land or premises . . . held or occupied by another . . . without having first obtained the permission of the occupier or holder thereof . . ." *Ord. No. 49, Secs. 1 and 2*

In locations and within limits governed by its zoning ordinance, Duluth, Minnesota, provides for revocable permits for keeping livestock, conditioned that:

> "The premises . . . shall be open to the inspection of the director of public health or his agents at any time. Such premises . . . where such animals are kept shall be kept in a clean, sanitary well-drained condition at all times." *Code, Sec. 6-17*

Location of Animal Housing

Frequently "buffer zones" between the places where animals are kept and residences, etc. are established by regulatory ordinances. Examples are those of Ogden, Utah, Little Rock, Arkansas, and Greenwich, Connecticut, as follows:

> "It shall be unlawful . . . to keep or maintain any barn, stable, shed, corral, or hive in which are kept horses, cows, poultry, animals, or bees, within seventy-five feet of any dwelling, house or residence or public street . . ." *Code, Sec. 15-1-14*

> "It shall be unlawful to keep cows, goats, or other hoofed animals in a pen or lot within seventy-five feet of any residence other than the residence of the livestock owner. It shall be unlawful to keep cows, goats or other hoofed animals in a pen or lot within seventy-five feet of any business establishment which is regularly used by large numbers of people." *Code, Sec. 7-1*

> ". . . No house for goats, swine, poultry, or pigeons and no yard or run for the same shall be built or maintained within fifty (50) feet of any dwelling, apartment, tenement, or other inhabited buildings, or of any reservoir, well, artesion or otherwise, lake, pond, brook, stream, river or drainage ditch." *Sanitary Code, Sec. 1.2*

Stables, Etc.

While in some cases detailed specifications for construction of stables are enacted, consideration is here limited to operational sanitation. Overall requirements to maintain a "clean and sanitary condition" are exemplified by the ordinances of Rhinelander, Wisconsin, Independence, Missouri, and Twin Falls, Idaho, respectively:

> "All structures, pens, buildings, stables, coops or yards wherein animals or fowl are kept, shall be maintained in a clean and sanitary condition, free of rodents, vermin and objectionable odors. . . ." *Code, Sec. 12.06 (3)*
>
> ". . . Every stable or other structure wherein any horses, mules, asses, ponies, goats, sheep, swine, or cattle are kept shall be maintained in a clean and sanitary condition at all times devoid of all rodents and vermin, and free from objectionable odors. . . ." *Code, Sec. 3.12*
>
> "Animals locations, structures, pens, corrals and any other premises or structure used for the keeping of and maintaining of horses, cows, sheep, goats, rabbits, chickens, doves and pigeons or any other animals must be kept in a clean and sanitary condition, free from obnoxious odors and substances. . . ." *Code, Chaps. VII, Art. I, Sec. 7*

Specific requirements as to *cleansing* such facilities have been deemed necessary in certain cases, as per the following of Mobile, Alabama, Nashville and Davidson Counties, Tennessee, and Des Plaines, Illinois, respectively:

> "Every stable, shed or lot where a horse, mule or cow is kept . . . shall be thoroughly cleaned at least once each day and every stable, shed, or other building in which such animals are kept shall have sufficient light to make cleaning practicable . . ." *Code, Sec. 7-15*
>
> ". . . Any owner, agent or occupant of any stable . . . in which any horse, cattle or swine or any other animal shall be kept . . . who shall fail to comply with the nocie of the (Health) Department to cleanse, remove or repair such stable . . . or to keep same in a sanitary condition, shall be guilty of a misdemeanor." *Public Health Code, Chap. 11*
>
> "It shall be unlawful . . . to construct any stable, barn or shed for the housing or keeping of horses or other animals on any lot on any street or alley in which a public sewer is constructed without providing the stable, barn or shed with an impervious floor properly drained to the sewer." *Code, Sec. 6-3-1*

Characterization as *nuisances* is an approach to coping with unsanitary conditions which numerous cities use, including three so geographically spaced as Portland, Oregon, Grand Forks, North Dakota, and Concord, New Hampshire—whose ordinances, respectively, provide that:

> "Any barn, stable, shed, coop, or other building or structure of whatsoever kind or nature in which any domestic animal or domestic fowl is or are kept or housed and which is unsanitary or unhealthful to man or beast, is hereby declared to be a nuisance. The owner, occupant or person responsible for said building or its conditions shall upon 48 hours notice from the Bureau of Health forthwith abode said nuisance." *Health & Sanitation Code, Sec. 18-1802*
>
> "Whenever any . . . barn, stable, livery stable, cow yard, shed, hog pen or sty . . . shall be . . . in such a condition . . . as to endanger the public health, the same . . . is hereby declared a nuistance . . ." *Code, Sec. 10-0104*
>
> "No person . . . shall keep or use any hog-pen, goat-pen, chicken-coop, or barnyard so near to any highway, park, or other public place, as to be offensive, or a menace to the public health, or offensive, or a menace to any person or persons residing on an adjoining or abutting lot . . . All petitions for the cleansing, removing, or abatement of any nuisance shall be made to the sanitary inspector . . . stating distinctly the character of such nuisance, the premises where situated, and the reason for its removal or abatement . . ." *Code, Sec. 11.5 and 11.6*

Manure

To cope with a major byproduct of stables, San Antonio, Texas, requires that:

> "All manure and other animal wastes from livestock shall be removed from pens, corrals or standings at least once each day. This material shall be deposited in a manure storage bin of concrete or metal construction and shall be provided with a fly-tight lid. Such manure and other animal wastes shall be removed from this bin at least once each week to a disposal site approved by the director of public health." *Code, Sec. 6-14(b)*

More frequent summer-time removals are required by Des Moines, Iowa, and New Orleans, Louisiana, respectively, to wit:

> "It shall be the duty of the owner or occupant or tenant or keeper of any boarding, sales, livery or other stables, where any horse, mule, cow or other animal is kept, to remove or cause to be removed, all manure from such stables or premises at least twice weekly from March fifteenth to

> December first or oftener as deemed necessary and once a week from the first of December to the fifteenth day of March, and such owner or occupant or tenant or keeper shall be required to store in fly-proof receptacles, not accessible to flies, all such manure pending its removal." *Code, Sec. 24-64*
>
> "Any person, firm or corporation, . . . having or permitting on his or its premises less than six horses, mules, cows or other animals, shall remove or cause to be removed daily all manure, and straw, hay or similar material used for bedding and contaminated with manure and/or urine . . . which matter shall be stored in leak-proof containers, having solid metal covers, tightly fitted so as to render the contents thereof inaccessible to flies. All such stored matter shall be removed from such premises not less than twice weekly from March fifteenth to December first and not less than once each week from December first to March fifteenth. Any person . . . having . . . more than five horses, mules, cows or other animals shall remove . . . the contents thereof . . . from the premises daily . . ." *Code, Sec. 29-60*

A comprehensive chapter on the subject has been enacted by Louisville, Kentucky, which is briefed as follows:

> "It shall be the duty of every person . . . having charge of any public or private stable, barn or place where . . . livestock are kept, to have . . . at all times upon the premises . . . a receptacle of sufficient dimensions which shall be flyproof from March to November of each year, for the purposes of containing the droppings of manure . . . each day . . . deposited therein . . . the contents of such receptacle to be removed from the premises at least once a week and oftener if required by the Health Department, such requirements applying to the period between March and November of each year. No receptacle shall be constructed or used for holding manure, the bottom of which is below the surface of the surrounding earth, unless it be constructed of substantial cement or masonry and connected with the public sewers. Manure shall be removed . . . at the expense of the owner . . . and shall not be used as fertilizer . . . without the permission, in writing, from the Health Department. . . ." *Code, Chap. 1103*

Animal-Care Establishments

Sanitary regulation of *kennels* is exemplified by ordinances of Des Plaines, Illinois, *(which includes catteries)*, and Duluth, Minnesota *(which includes dog and cat hospitals)*, respectively:

> "All dog kennels and catteries shall be kept free and clean from decaying food and from filth of any kind. The kennels, buildings and pens shall be whitewashed or disinfected, from time to time, and shall be kept in a sanitary condition satisfactory to the Building Commissioner and Zoning Administrator and the Health Officer." *Code, Sec. 5-4-13.7*
>
> "It shall be the duty of each operator of a licensed dog and cat hospital to operate and maintain such hospital, as well as all of its pens, cates, runways and all the premises upon which it is situated, or which constitute a part of its operational area, in a clean and sanitary manner, . . . to dispose of urine and fecal material through an approved sewer system; . . . to keep the premises vermin free; and to conduct its operations in such a manner that no public nuisance will be created . . ." *Code, Sec. 6-31*

Dead Animals

When the family pet, or any animal, passes on he becomes a different type of sanitary disposal problem. As a class of urban refuse, "dead animals" are those that die naturally or from disease or are accidentally killed; excluded are condemned or slaughtered animals. Common requirements are that dead animals be disposed of promptly but not by being deposited or abandoned in any public place.

Considered as a *nuisance*, Dayton, Ohio, asserts that:

> "It is hereby declared to be a nuisance and to be unlawful for any person being the owner of an animal to fail to remove the carcass of any such animal within ten hours after the death of said animal; said removal shall be either to a point beyond the City corporate limits or to any regularly established reduction plant for the disposal of carcasses . . ." *Code, Sec. 835*

Depositing carcasses in public places is treated briefly in Salina, Kansas, and at greater length in Des Moines, Iowa, as reflected by their respective ordinances:

> "Any person who shall place any carcass of dead animals . . . upon any street or alley, shall be guilty of a misdemeanor." *Code, Sec. 32-6*
>
> "It shall be unlawful for any person to place any dead animal in any street, alley or other public place in the city, or to allow any dead animal, which he owned, or of which he had control, to remain in any street, alley or other public place or on the premises of any person within the city for more than five hours.

> Should an animal die in any street, alley or other public place or on the premises of any person within the city, then the person who owned or had possession and control of the animal prior to death, shall remove or cause to be removed the carcass within five hours from the time the animal dies, and have the same desiccated or cremated. It shall be the duty of the owner, possessor and all persons having knowledge of any dead animal in the city to report the same to the department of public health, giving the name of the person who owned or had possession or control of the animal prior to its death and the place where the same may be found and it shall be the duty of the department of public health to immediately notify the person who owned or had possession and control of such animal to cause the same to be removed and desiccated or cremated as provided by . . . this Code." *Code, Sec. 5-15 and 5-16*

Carcasses in water or waterways are of course particularly objectionable and their placement in such situations is proscribed by various ordinance including those of St. Paul, Minnesota, Grand Forks, North Dakota, and Ogden, Utah, which follow (with emphasis supplied) respectively:

> "No owner or possessor of any animal which shall have died shall suffer the same to lie on any public ground, street, alley or any private lot or place within the city; nor shall any person throw or leave any such animal . . . into *any pool of water* in said city." *Code, Sec. 265.31*
>
> ". . . no person shall throw, place, or deposit, or cause to be thrown, placed, or deposited, at any place within the city, remains of any animal whatever and no person shall allow or suffer any horse, cow, ox, hog, or other animal belonging to him or in his charge, which may come to its death by drowning or otherwise, to be or lie *in the Red River of the North, or in any other waters* of said city, or in or upon any lot, ground, street, lane, avenue, or alley or other place either public or private, within the city. . . ." *Code, Sec. 10-0109*
>
> "It shall be unlawful for any person to leave exposed in any street, avenue, highway, alley, lot, public ground *or water course* within the city the carcases of any dead animal, or any unsound meat, fish, or other substance or to permit the same to be done with his consent, . . . It shall be the duty of all persons owning or having charge of animals, which shall die or be found dead, to have the said dead animals removed, at his or their own expense, to the city dump or to an authorized by-products company, . . . and if the persons whose duty it is to dispose of said animals . . . shall fail for twenty-four hours to discharge their duties as herein required, it shall be the duty of the Health Official to have the same disposed of at the expense of the party whose duty it may be to dispose of the same." *Code, Sec. 15-1-2, 15-1-3*

Moribund animals are also specifically within the proscription at Saginaw, Michigan, whose ordinance (emphasis supplied) stipulates that:

> "No person shall deposit, place or throw any dead or *fatally sick or injured* animal . . . on any public or private place, or into or on the banks of, any stream, lake, pond, sewer, well or other body of water." *Code, Sec. 105.9*

Disposal by *incineration* is prescribed by Des Plaines, Illinois, which requires that:

> "Any person being the owner or occupant of any premises within this City, having a dead animal on the premises shall at once remove or cause the removal of the animal to the City Incinerator to be disposed of there." *Code, Sec. 6-3-5*

Regulated *burial* is authorized in some cases, usually as an alternative, in such ordinances (emphasis supplied) as those of Dayton, Ohio, Oakland, California, Denver, Colorado, and Westport, Connecticiit, respectively:

> ". . . if any person shall place . . . in any street, lane, alley, lot, common, or water course . . . the carcass of any dead animal . . . and shall leave the same exposed *or unburied*, such person . . . shall pay a fine . . ." *Code, Sec. 937*
>
> "It shall be the duty of all persons having dead animals upon premises, . . . *to bury the same* under at least four (4) feet of packed earth cover, except cats, dogs of fowl and birds, which shall be buried under at least three (3) feet of packed earth cover, either upon the premises of the owner or upon the premises where such animal if found, or in other approved burial places for dead animals, or to have such dead animal cremated by private contract or by the City Pound . . ." *Code, Sec. 3-9.21*
>
> "It shall be the duty of the owner of any animal found dead . . . within six (6) hours after the death of said animal to arrange for its removal *and burial* or rendering in accordance with . . . applicable law." *Code, Sec. 750.7-2 (2)*
>
> "No small dead animals shall be disposed of except as herein provided. It may either (a) *be buried* in a hole and covered with dirt to a depth of at least two feet, or (b) be prepared for disposal at the disposal area by placing it in a carton, heavy paper bag or burlap sack clearly labeled 'Dead Animal' in large letters and shall not be intermixed with garbage." *Refuse Ordinance Art. VII*

However, other cities *forbid burial* (as in the case of Duluth, Minnesota), though often narrowly limited exceptions are provided (as in the case of Council Bluffs, Iowa, and Saginaw, Michigan. Their ordinances (with emphasis supplied) follow, respectively:

> ". . . No such owner or possessor of any such animal shall suffer the same to lie on *or be buried in* any public grounds, street, lane or alley or any private lot or place within the city." *Code, Sec. 24-27*
>
> "It shall be unlawful for any person to bury and dead animal upon property within the city *except in duly constituted cemeteries* and no dead animal shall be otherwise disposed of except as hereinafter provided." *Code, Sec. 4.12.180*
>
> "No person shall bury any . . . animal . . . in the city *except* that the owner or occupant of *any unplatted property* may bury thereon any dead animal owned by him dying on such premises, after having obtained a written permit to do so from the Health Officer. Such burial shall be made at a distance of not less than two hundred (200) yards from any residence and the carcass shall be placed underground and well covered with at least four (4) feet of earth from the surface of the ground to the upper part of the carcass." *Code, Sec. 105.10*

Specific *contract disposal* is utilized in Denver, Colorado, whose pertinent ordinance provides that:

> "The Manager of Public Works is hereby authorized and directed . . . to contract for the removal of carcasses of all dead animals lying in the streets, alleys, or other public ways and places of the City and County of Denver, or on private premises therein. The Contractor . . . shall execute . . . a bond . . . of Ten Thousand Dollars . . . conditioned for the faithful and punctual performance of the duties imposed . . . The Contractor . . . shall have the exclusive right to remove and dispose of all carcasses of dead animals found lying in the . . . public ways and places . . . or on private premises . . . not removed by the owner within six (6) hours of daylight time following the death of such animal. It shall be the duty of the Contractor, twenty-four (24) hours after notification of the whereabouts of any dead animal, to remove and dispose of the same. Utmost precaution shall be used in the removal of such dead animals, that the same may be conveyed in the most inoffensive manner possible. . . ." *Code, Sec. 750.7-3*

Public *officers are responsible* for removal of dead animals in various jurisdictions as typified by the ordinances of Saginaw, Michigan, and Independence, Missouri, which follow:

> "Any dead animal or part thereof, lying upon any street, alley or public place, shall be removed by the Police Department forthwith. If any dead animal, or part thereof, is upon private property, the owner or person in charge of such animal at the time of its death shall dispose of the same, or shall immediately report the facts to the Police Department, which department shall remove such animal forthwith. When any dead animal, or part thereof, is removed from the private property by the Police Department, a fee shall be charged to the owner of the animal for such removal, which fee shall be determined by administrative regulation." *Code, Sec. 105.12*
>
> "The public humane officer shall be responsible for the prompt removal of all dead animals found within the city whenever reported to him or when requested to do so by the director of health. The removal and disposal of dead animals shall be by a sanitary method approved by the director of health. No person owning or having in his possession a carcass of any animal . . . shall suffer the same to be or remain in or on any . . . public ground, or any private lot or place without at once giving immediate notice thereof to the chief of police or public humane officer. In case the owner or person having charge of any dead animal shall neglect or refuse to remove the same within ten (10) hours of its death, the public humane officer, director of health, or police department shall cause the same to be removed at the expense of such owner or person having charge of the same, such expense to be recovered by civil action. Whenever the owner of any dead animal cannot be found or ascertained, it shall be the duty of the public humane officer, health department, or police department to cause such animal to be removed and buried at the expense of the city, in a method and manner prescribed by the director of public health." *Code, Secs. 3.21 - 3.23*

PRODUCE MARKETS

Varied approaches to cleanliness in and around public market areas are typified by ordinances received from various cities. Their construction is regulated by an ordinance of San Antonio, Texas, which requires that:

> "Curb or farmers' markets in which fruit or vegetables or any other food products are exposed and offered for sale . . . shall have floors paved with concrete or asphalt for the entire surface area of the market. . . ." *Code, Sec. 18-50*

Sanitation requirements are incorporated into leases for market spaces in Richmond, Virginia, under uniform contracts which include a provision that:

> "the lessee will keep the space leased in a clean and sanitary condition at all times and will dispose of his refuse in a manner and at the place required by the director; . . ." *Code, Sec. 9-9*

This is backed up by an ordinance which declares that, among other things:

> "It shall be unlawful for any farmer or other person using leased space in any building in the market areas: (1) To fail, refuse or neglect to keep the leased space in a clean and sanitary condition at all times: (2) To fail, refuse or neglect to dispose of his refuse in a manner or at the place required by the director, . . ." *Code, Sec. 9-11*

Substantially the same requirements apply to:

> "Every farmer selling or offering farm products for sale on a street in the market areas (who) shall keep the space in the street so used in a clean and sanitary condition at all times and shall dispose of his refuse in a manner and at the place or places required by the director." *Code, Sec. 9-13*

San Antonio imposes several specific requirements for cleansing, asserting that:

> "(a) All vegetable and fruit stands shall be thoroughly cleaned by occupants and ready for inspection by the market master by ten o'clock a.m. on each day" and "(d) Occupants of stands are required to assist in keeping clean the immediate vicinity of the stands in their charge, and shall keep on hand the necessary brooms and other tools for that purpose." *Code, Sec. 21-9*

San Antonio also governs operations of the produce stands via four-stage provisions for "disposal of garbage and waste" which ascent in intensity as follows:

> "(a) No leaves or litter of any kind shall be thrown upon the floor while vegetables are being cleaned or picked over, but such leaves and other matter must be placed in a container and transferred to the garbage can in the rear of all stands; (b) All rotten or decayed vegetable matter to be disposed of must be placed in the garbage can immediately after being picked over and such garbage can shall be kept covered; (c) Slightly decayed fruits and other such substances to be removed from the market places as soon as possible; and (d) All spoiled or unsaleable meat and offal must be placed in a well-covered garbage can or immediately removed from the market places." *Code, Sec. 21-10*

FOOD PROCESSING PLANTS

Akin to the produce markets are various food-processing and food-handling establishments which are customarily subjected to detailed and stringent sanitary regulations. While these customarily and predominantly relate to their interior facilities and internal operations, our interest here is confined to "externals"—cleanliness of premises and environs and disposition of waste.

Slaughter Houses and Meat Packing

With respect to the premises of meat-processing establishments, Saginaw, Michigan, has in its comprehensive ordinance a relatively simple provision that:

> "Any slaughterhouses, pens and enclosures connected therewith shall be kept in a clean, sanitary condition free from an accumulation of refuse, garbage and offensive material, and nuisances of every kind." *Code, Sec. 1004.17*

The physical premises are emphasized in a provision of the Meat Inspector Ordinance of Albuquerque, New Mexico that:

> "The premises of every establishment, including the docks and areas where cars and vehicles are loaded and unloaded, and the driveways, approaches, yards, pens, and alleys should be paved, or properly graded and drained, and kept clean and in an orderly condition." *Ord. No. 1503 of 4/28/59, Sec. 20(A)*

Hawaii County, Hawaii, carries virtually the same language, adding that:

> "All catch basins on the premises shall be of such construction and location and be given such attention as will insure their being kept in acceptable condition as regards odors and cleanliness. The accumulation on the premises of any material is which flies may breed, such as hog hair, bones, paunch contents, or manure, is forbidden. . . ." *Ord. No. 47, Sec. 7(f)*

Paving is specified in the ordinances of Little Rock, Arkansas, and of Nashville and Davidson Counties, Tennessee, which respectively prescribe that:

> "All yards, pens, chutes and alleys adjacent to the abbattoir shall be concreted and kept in a sanitary condition." *Code, Sec. 14-46(j)*

> "The premises inside and out shall be well drained and kept free of debris, flies, vermin, insects, rodents, dust, and kept in a clean and sanitary condition at all times. Holding pens, alleys, loading areas and ramps shall be properly paved and kept clean, well drained and free of vermin. . . ." *Public Health Code, Sec. 3.208*

Des Moines, Iowa, stresses "materials" and "facilities" in two provisions which prescribe that:

> "All pens, chutes, alleyways . . . and all floors thereof, of any stockyard, salebarn, packing house, slaughterhouse or other place where animals are confined shall be constructed of material capable of being washed, cleaned and disinfected." *Code, Sec. 24-83*
>
> "All stockyards, salebarns, packing houses, slaughterhouses, and other places where animals are confined . . . shall be equipped with water facilities adequate to wash and hose all pens, chutes, alleyways and floors thereof, and with adequate and proper drainage." *Code, Sec. 24-82*

Waste disposal from meat-processing establishments is governed in Saginaw, Michigan, by requirements that:

> "Water-tight, fly-tight, properly covered, metal containers shall be provided for temporary storage of waste and garbage. All bones and meat scraps shall be kept in a refrigerator in covered metal containers. Waste and garbage shall be removed and cans washed as frequently as is necessary to prevent any nuisance or unsanitary condition." *Code, Sec. 1514.1*

The requirement in Albuquerque, New Mexico, is similar:

> "All waste shall be properly disposed of, and all inedible products and trash shall be kept in suitable receptacles in such a manner as not to become a nuisance. Containers used for the collection and holding of solid wastes shall be kept covered or otherwise protected at all times so that such wastes shall not be accessible to flies, rodents, or other vermin."

Little Rock, Arkansas, governs waste disposal at fish-dressing plants and at poultry-and rabbit-dressing plants under identical provisions that:

> "Waste matter as hereinafter defined must be disposed of as follows: (a) *Liquid wastes.* Proper facilities must be provided for the collection and disposal of all liquid wastes, including blood, floor washings, and other material. These wastes shall not be discharged on the surface of the ground nor into a flowing stream or body of water that may endanger a public or private water supply or be determined to public health. (b) *Solid wastes.* Offal, fat, refuse and waste material must be placed in covered metal containers and disposed of in a sanitary manner immediately after the day's operation. All garbage receptacles shall be washed when emptied and treated with a disinfectant. . . ." *Code, Secs. 14-69 and 14-103*

Twin Falls, Idaho, provides rather broadly that:

> "It shall be unlawful for any person to throw, place or conduct into or upon any street, alley, lot, or into any aqueduct, gutter or canal, any putrid or unsound meat, fish, hides, or skins of any kind, or filth, offal, dead animals, vegetables, or any unsound or offensive matter whatsoever; provided, however, that this section shall not apply to the spreading of manure upon land for the purpose of fertilizing the soil." *Code, Art. IV, Sec. 10 (p. 1012)*

FOOD HANDLING ESTABLISHMENTS

The environmental sanitation and waste disposal aspects of businesses purveying or serving food are covered in greater or less detail in various ordinances examined. The comprehensive "Food Ordinance" of Hazel Park, Michigan, which provides thorough inspection procedures contains only two brief specifice, to the effect that:

> "The premises of all food establishments shall be kept clean and free of litter or rubbish" and "All wastes shall be properly disposed of and all garbage and rubbish shall be kept in suitable receptacles in such a manner as not to become a nuisance. . . ." *Ord. No. 347 of 1/10/64, Secs. 32 and 28.*

In its "Food Service Sanitation Ordinance" Albuquerque, New Mexico, offers greater specifics, especially as to waste disposal, in providing that:

> "All parts of the establishment and its premises shall be kept neat, clean, and free of litter and rubbish. . . ." and "All refuse containing fond wastes shall, prior to disposal, be kept in leakproof, nonabsorbent containers which shall be kept covered with tightfitting lids when filled or stored, or not in continuous use; provided, that such containers need not be covered when stored in a special vermin-proofed room or enclosure, or in a food-waste refrigerator. All other refuses shall be stored in containers, rooms, or areas in an approved manner. The rooms, enclosures, areas, and containers used shall be adequate for the storage of all refuse accumulating on the premises. Adequate cleaning facilities shall be provided, and each container, room, or area shall be thoroughly cleaned after the emptying or removal of refuse. Food-waste grinders, if used,

> shall be installed in compliance with State and local standards and shall be of suitable construction. All refuse shall be disposed of with sufficient frequency and in such a manner as to prevent a nuisance." *Ord. No. 2191 of 9/25/62, Secs. 7-E and 6-F*

In its "Health and Safety Code" Richmond, California, includes under "Food Establishments" both the processing and the dispensing of food products, hence governing both by the requirements that:

> "The premises, including parking lots, sidewalks, and services areas, of all food establishments shall be kept clean and free of litter, garbage, or rubbish." *Ord. No. 1746 of 10/16/61, Sec. 4.4. (F-18)*
>
> "All wastes shall be regularly and properly disposed of and all swill, garbage, rubbish, or refuse shall be kept only in metal receptacles. All such metal receptacles shall be provided with tight-fitting metal covers. If kept outside of the building, these receptacles shall be kept covered with such covers at all times except when swill, garbage, or refuse is being placed therein or removed therefrom. . . ." Ord. No. 1746 of 10|16|61, Sec. 4.4 (F-19).

Columbia, South Carolina, "ties in" food handling establishments in an even more general requirement that:

> "It shall be unlawful for any person to scatter, spill, expose or otherwise distribute such garbage as kitchen or table waste or refuse food material of any kind on the sidewalks, streets, alleys, vacant lots or open places in the city. This section applies to persons operating food stores, restaurants, hotels and boardinghouses, as well as individuals occupying private residences." *Code, Sec. 15-39*

WEED CONTROL

While public curtailment of the growth of weeds is largely based on considerations of health, aesthetics and/or fire prevention they also constitute, and conceal, refuse which is a source of surface pollution. Regulatory ordinances are often keyed to the *height* of the weeds, with twelve inches the usual mark beyond which they grow at their peril. A simple stipulation is the following of Daytona Beach, Florida, that:

> "It shall be unlawful for any person to permit upon any lot owned, leased or occupied by him, any weeds or grass to grow to a height of over twelve inches from the ground." *Code, Sec. 17-19*

In slightly greater detail, Jacksonville, Florida, ordains that:

> "It shall be unlawful for any person to permit upon any premises owned or held under lease of more than a one year term any weeds, grass or underbrush to grow to a height exceeding twelve (12) inches from the ground." *Ord. No. T-48 of 11/7/27, Sec. 1*

The onus is soley upon the owner in Rockville, Maryland, whose ordinance declares that:

> "It shall be unlawful for any owner of any land within the corporate limits . . . to permit said land to become overgrown with weeds. When . . . an owner of such land has permitted weeds to grow to a height of twelve (12) inches or more, notice shall be sent . . . ordering said owner to cut said weeds . . ." *Code, Sec. 10-1.08*

Allowable *height varies*, and the responsibility for weed control goes *beyond property lines* in some cases, as indicated (with emphasis supplied) by pertinent ordinances of Akron, Ohio, Wichita, Kansas, and Euless, Texas, respectively:

> "It shall be unlawful for any owner, lessee, or occupant, or any agent, representative or employee of any such . . . to permit *on or along the sidewalk, street or alley or between the property line and the curb or for ten feet outside the property line if there be no curb*, any growth of weeds, grass or other rank vegetation to a greater height than *six inches on the average*, or any accumulation of dead weeds, grass or brush. It shall be the duty of any owner, lessee or occupant to maintain in a clean and satisfactory manner *such property between the property line and the curb in front or adjacent to the property* and to cut and remove or cause to be cut and removed all such weeds, grass or other rank, poisonous or harmful vegetation as often as may be necessary to comply with the provisions of this ordinance. . . ." *Code, Sec. 39-13*
>
> "The owners, occupants or persons in charge of any lot or piece of land in the city are hereby required to cut, destroy and remove all weeds and obnoxious growths of vegetation *over eighteen inches high* upon any lot or piece of land *or upon the streets and alleys in front of and abutting upon* any such lot or piece of land." *Code, Sec. 7.52.020*
>
> "It shall be unlawful for any person owning, claiming, occupying or having supervision or control of any real property . . . to allow or permit weeds, brush or other vegetation not an agricultural

> crop under cultivation, *to grow to a greater height than twelve (12) inches* upon any such real property within 150 feet of any property line, or within 50 feet of any residence, barn or commercial building . . .It shall be the duty of such person to keep *the area from the line of his property to the curb line next adjacent to it* free and clear of weeds, brush and objectionable vegetation . . ." *Ord. No. 223 of 5/12/64, Sec. 2*

Noxious Weeds

Similar requirements, but focussed upon "noxious" vegetation, are found in the Ogden, Utah, and Salina, Kansas, stipulations that:

> "It shall be unlawful for any person . . . controlling any real property . . . to allow weeds or noxious vegetable growth to grow and remain in or upon such real property or in alleys abutting thereon, or the sidewalk areas in the front thereof to any height exceeding one foot." *Code, Sec. 15-1-27*
>
> "It shall be unlawful for any . . . person in charge of any lot or piece of land within the city to permit the growth thereon or in the streets and alleys in front of and abutting upon any such lot or piece of land of weeds, rank grass or other obnoxious growths of vegetation . . ." *Code, Sec. 15-40*

The Bettendorf, Iowa, ordinance not only lists "noxious" weeds (sow thistle, Canada thistle, bull thistle, European morning glory or field bindweed, horse nettle, leafy spurge, pepper-grass, Russian knapweed, butterprint, cocklebur, wild mustard, wild carrot, buckhorn, sheep sorrel, sour dock, smooth dock, puncture vine) but relates destruction requirements to their life cycle, thus:

> "The owner and person in the possession or control of any lands within the city shall cut, burn, or otherwise destroy all noxious weeds thereon at such times in each year and in such manner as shall prevent such weeds from blooming or coming to maturity . . . Noxious weeds shall be cut or otherwise destroyed on or before June 10 of each year and as often thereafter as is necessary to prevent seed reproduction." *Code, Sec. 7.15 (b) and (c)*

Specialized definitions of weeds subjected to controls are written into the Albuquerque, New Mexico, and San Francisco, California ordinances, respectively as follows:

> ". . . shall include, but shall not be limited to tumbleweeds, grass and all rank, noxious, poisonous, harmful, unhealthful vegetation, and any growth whatsoever of an offensive nature or deleterious to health." *Ord. No. 2703 of 8/10/65, Sec. 2 (6)*
>
> "All weeds . . . which bear seeds of a wingy or downy nature or attain such a large growth as to become a fire menace when dry, or which are otherwise noxious or dangerous . . ." *Public Works Code, Sec. 741*

The Nuisance Concept

A usual regulatory procedure is to declare stipulated weeds a "nuisance" which can then be abated by city forces at the owner's expense when he has failed after due notice, to take the corrective action. A very sweeping provision aimed in that direction is that of Grand Forks, North Dakota, asserting that:

> "All weeds growing within the limits of the City are hereby declared to be a common nuisance and it shall be the duty of every person owning, occupying, or in charge of any premises, lot, or parcel of land in said city to keep such premises, lot, or parcel of land free from all weeds and to cut and destroy the same at all times during the growing season." *Code, Sec. 10-0115*

Time Cycles for Clearance

Regulatory ordinances sometimes provide rather specified schedules for cutting and removing weeds—such as the following of Wethersfield, Connecticut, Lincoln, Nebraska, and New Rochelle, New York, respectively:

> "In May and August of each year every . . . person in possession of land shall cut to a height of not more than eight inches all weeds and similar vegetation . . ." *Ordinance of 11/19/62, Sec. 1*
>
> "It shall be the duty of every owner of real estate . . . to cut and clear . . . all weeds and worthless vegetation on or before the fifteenth day of May, again on or before the first day of July, again on or before the fifteenth day of August, and again on or before the fifteenth day of November of each year. . . ." *Ord. No. 3780 of 11/18/40, Sec. 1*
>
> "It shall be the duty of any owner, lessee or occupant of any lot or land to cut and remove . . . weeds, grass or other rank, poisonous or harmful vegetation as often as may be necessary . . . *provided* that cutting and removing such weeds, grass and vegetation at least once in every three weeks between May 15 and September 15 shall be deemed to be a complian . . ." *Code, Sec. 11-9*

Refuse—Combination and Concealment

In its regulatory ordinance definitions, St. Paul, Minnesota makes the point (emphasis supplied) that weeds have other than their own inherent vices where public sanitation is concerned:

> ". . . The word 'weeds' shall also be construed to mean . . . high and rank vegetable growth that *may conceal filthy deposits.*" *Code, Sec. 456.03*

In similar vein, Ogden, Utah, notes "pollution of water" (emphasis supplied) among the deleterious possibilities justifying weed control, thus:

> "It is the purpose . . . to establish a means . . . (for) the removal or abatement of injurious and noxious weeds, and of garbage, refuse, or unsightly or deleterious objects or structures . . . It is hereby declared that the above listed weeds, objects and structures shall constitute a nuisance when they create a fire hazard, *a source of contamination, or pollution of water*, air or property, a danger to health, a breeding place or habitation for insects or rodents or other forms of life deleterious to human habitations or are unsightly or deleterious to their surroundings." *Code, Sec. 15-3-1*

Examples of refuse bracketed with vegetation are shown below (with emphasis supplied) in the weed control ordinances of Richmond, California, Greensboro, North Carolina, and Daytona Beach, Florida, respectively:

> "It shall be unlawful . . . to cause or permit any weeds, *or to place, cause or permit any rubbish*, to be or remain on any real property in the City . . ." *Ord. No. 1457 of 8/23/65, Sec. 3*

> "Every person owning or occupying any premises in the city shall keep such premises free from noxious weeds, *trash and all other forms of offensive animal or vegetable matter or refuse* which may be dangerous or prejudicial to the public health or which may constitute a public nuisance." *Code, Sec. 8-20*

> "If at any time the commission shall deem it necessary . . . that any lot, tract, or parcel of land . . . be cleaned of weeds, *trash, undergrowth, brush, filth, garbage or other refuse*, it shall have power to direct and require the owner . . . to clean the same . . ." *Code, Sec. 16*

GARDEN REFUSE

Tree trimmings, grass clippings and other types of lawn and garden refuse are often included in bans upon the throwing or depositing of litter, as exemplified by the pertinent ordinances of Prichard, Alabama, Sturgis, Michigan, and Scottsdale, Arizona, respectively:

> "It shall be unlawful . . to place, throw, deposit, or . . . cause to be placed . . . or left on any street, alley or driveway, between the curb lines thereof, . . . any trash from lawns, cuttings from lawn, cuttings from trees, or any other debris of any kind or description of a nature likely to stop up or impede the flow of water through the storm sewers or other drains . . ." *Ord. No. 389 of 1/2/40, Sec. 1*

> "It shall be unlawful . . . to throw, scatter, sweep, deposit or leave in any public street, sidewalk, alley, parkway, or public parking lot or upon any other grounds, either public or private, any . . . leaves, grass, clippings, garden wastes, trees, branches of trees, shrubbery or other litter." *Ord. No. 46-A, Sec. 1*

> "No paper, lawn cuttings or rakings, leaves, weeds, ashes, or any refuse material whatsoever shall be thrown or swept into any street, gutter, sewer, alley, vacant lot, park, greenbelt, or other property whether public or private. It shall be the duty of every owner, occupant, or person in charge of any property at all times to maintain said premises in a clean and orderly condition, permitting no deposit or accumulation of materials other than those ordinarily attendant upon the day to day use for which said premises are use. . . ." *Ord. No. 116 of 5/16/61, Sec. 5*

The location of lawn and garden refuse, when placed for collection, is regulated by such ordinances as those of Daytona Beach, Florida, and Modesto, California, which follow:

> "Grass, leaves, small twigs, branches, yard trimmings, etc., shall be neatly piled together on the parking or next to the street line so they may be handled with ease, but no such piling shall be done in the street, gutters, nor so that water may wash it into other locations. . . ." *Code, Sec. 17-14*

> "The following regulations shall govern the placement of garden refuse for collection by the City. (a) Place. Persons desiring to have garden refuse collected by the City shall place it in the abutting alley, if one exists. Where alleys do not exist, garden refuse shall be placed in the abutting street for collection. *(b) Location.* Garden refuse placed in streets shall be placed in a compact manner and shall not extend into the street more than four (4') feet, nor shall the closest edge of the pile be placed less than one (1') foot from the face of the curb, or in case no curb exists, from the low

> point of the gutter, so as to permit drainage. Garden refuse placed in alleys shall be placed in a compact manner and shall not extend into the alley more than three (3') feet. *(c) Piling*. Garden refuse shall be placed in a single compact pile and only in front of, in the rear of, or on the side of, as the case may be, the property where it was accumulated. *(d) Quantity*. Not more than two (2) cubic yards of garden refuse shall be placed in the street or alley for any one collection. *(e) Size*. All tree limbs, cuttings or shrubbery put out for collection shall not exceed eight (8') feet in length or six (6") inches in diameter, and no single piece shall weigh more than fifty (50) pounds. *(f) Containers*. When practicable, all small refuse, (grass, clippings, leaves, twigs, etc.) shall be placed in containers of not more than twenty (20) gallons capacity; provided, however that between October 1 and December 31 of each year, leaves need not be placed in containers. Containers used for small refuse shall be removed from the street or alley on the same day they are emptied. *(g) Time*. Garden refuse shall be put out for collection not later than 7 o'clock a.m. on collection day, and shall not be placed in the street more than one (1) day prior to the day of collection. . . ."

In Hawaii the collection of garden refuse is governed by such dimensional regulations as Honolulu's stipulation that:

> "All rubbish consisting of tree branches, tree trunks and stumps, hedge and plant cuttings, palm and coconut branches, vinces and other similar materials shall be cut into lengths not exceeding three feet and shall be tied in bundles which shall not weigh more than 50 pounds each." *Ord. No. 1478 of 12/5/55, Sec. 3(a)*

Neighboring Maui County's similar provision *(Code, Sec. 16-1.3)* allows a 75 pound weight per bundle and limits stumps to 75 pounds, but is otherwise identical.

Mobile, Alabama, also regulated primarily in terms of dimension and weight, thus:

> "Any person desiring to place tree trimmings or hedge cuttings or shrubbery of any kind for removal shall cause the same to be securely tied in bundles not heavier than seventy-five pounds nor more than five feet in length nor more than eighteen inches in diameter. Not more than two bundles shall be placed for removal on any one collection day. Ten bundles shall be placed in the same place, time and manner as provided for garbage and only on regularly designated collection days." *Code, Sec. 24-9*

Special Situations

For the benefit of persons in the *lawn-care* and related businesses, Scottsdale, Arizona, provides for a revocable permit to exempt them from a ban on private collection of trash, etc. and thus facilitate their work:

> ". . . any person engaged in the business of pruning and caring for trees, shrubs and flowers and the care and mowing of lawns may remove any rubbish resulting therefrom after first obtaining a permit so as to do from the Town Clerk . . ." *Ord. No. 7 of 2/13/52, Sec. 11*

Special authorization for *compost* is provided in the Boise, Idaho, ordinance, which specifies (emphasis supplied) that:

> "Trash consisting only of pasteboard, or wooden boxes, brush, leaves, weeds and cuttings from trees, lawns, shrubs and gardens may be kept separately without depositing same in cans or receptacles. *Compost piles may be maintained for fertilization purposes*, and matter used for fertilization purposes only may be transported, kept and used. . . ." *Code, Sec. 8-10-10*

DISCHARGE INTO SEWERS

All of the previously discussed categories deal with potential pollutants which may find their way into sewers—storm sewers, primarily—as a result of natural or rainstorm drainage, but in a basically unintentional manner. This final category, however, deals with pollutants which are introduced into sewers intentionally. More accurately they are substances sought to be so introduced but which governing authorities seek to debar from entry. The regulation and prohibition of particular discharges into sewers may be approached in relation to the recipient sewer or the substances in question. Both are considered in a standard reference in the field—Special Report No. 23 of the American Public Works Association, a 1959 booklet of "Guide-Lines for Drafting a Municipal Ordinance on Industrial Waste Regulations and Surcharges" by Edward J. Cleary. It includes "suggested phraseology for an ordinance" which is subsequently cited.

Sanitary Sewers

In communities with separate systems of storm and sanitary sewers there should be a prohibition against the use of sanitary sewers for any purpose other than the carriage of sewage and industrial wastes. The Cleary "suggested phraseology" from APWA Special Report 23 provided that:

> "No person shall cause to be discharged any storm water, sub-surface drainage, ground-water, roof runoff, cooling water or unpolluted water into any sanitary sewer." *Sec. 301*

In substantial conformity is the Milford, Delaware, stipulation that:

> "No person shall discharge or cause to be discharged any storm water, surface water, ground water, roof runoff, sub-surface drainage, cooling water or unpolluted industrial process waters to any sewer designated by the Council as a sanitary sewer." *Code, Sec. 411.3.C*

Different in language but of similar import is the Prichard, Alabama, provision that:

> "It shall be unlawful . . . to cause or allow . . . any discharge of surface waters or other waters customarily and naturally discharging into drains, ditches, storm sewers or substitutes therefor, into any portion of the Sanitary Sewage System . . ." *Ord. No. 556 of 5/19/52*

A particular reference to construction excavations was recently enacted at Miami, Florida, in providing that:

> "It shall be illegal to discharge waste water from a construction excavation into a city sanitary sewer." *Code, Sec. 54-9*

Des Moines, Iowa, acts to protect its sanitary sewerage system against "deleterious" matter in this manner:

> "The sewage shall not contain any substance which is deemed deleterious to the operation of the sewerage system. If the user of the sewer system contributes any objectionable substances he shall be required to discontinue the discharge of such substance into the sanitary sewer system. If after due notice he continues to permit the discharge of any deleterious substance into the sanitary sewer system he shall be guilty of a misdemeanor. Each calendar day in which he continues to permit the discharge of any objectionable substance into the sanitary sewer shall be considered as a separate violation." *Code, Sec. 48-41*

Combined or Storm Sewers

In relation to recipient sewers used wholly or in part for storm-water drainage, the Cleary phraseology in the APWA report specifies that:

> "Storm water, surface drainage, sub-surface drainage, ground water, roof run-off, cooling water or unpolluted water may be admitted to such sewers as are specifically designated as combined sewers or storm sewers and which have adequate capacity for their accommodation. No person shall use such sewers without first having obtained the consent of the Approving Authority." *Sec. 302*

The Milford, Delaware, stipulation substantially conforms, thus:

> "Storm waters and all other unpolluted drainage shall be discharged to such sewers as are designated as combined sewers by Council or to a natural outlet approved by Council. Industrial cooling water and air conditioning water may be discharged, upon approval of the Council, to a storm sewer or natural outlet." *Code, Sec. 411.3.C*

Miami, Florida provides for conditional acceptance of construction waste-water in its new provision that:

> "It shall be illegal to discharge waste water from construction excavations into a city storm sewer until the rules, regulations and requirements of the Department of Public Works governing such discharge have been fulfilled and a permit has been obtained from said Department allowing same." *Code, Sec. 54-10*

Specific Wastes

Prohibitions of limitations based on the nature of waste discharges may be broadly classified as falling into four categories. First are those which may directly or indirectly impair the construction and durability of the sewer system or its hydraulic functioning. Second are those wastes that may have a deleterious effect on the treatment-plant structures or processes. Third, there are wastes whose pollutional effect is not mitigated by the treatment process and whose presence in the receiving stream would violate state or interstate standards of water quality. And finally, there are wastes whose presence in the sewers could create a hazard to public health and safety, or which otherwise might cause conditions inimical to the public interest.

For the purposes of this study the third category is of primary, and the second of secondary, importance. The third class, wastes that have harmful characteristics not modified by the treatment process, may cause concentrations in the receiving stream that are inimical to persons, livestock or aquatic-life. A municipality must carefully guard against discharging into a stream an effluent containing radioactivity or toxic substances. Wastes that should be prohibited because of their possible effect on the treatment works include those that contain inert solids (e.g., cinders, sand, feathers, bones, hair, wood products, plastics and viscous substances) wastes of large volume having either a low or high pH value (say below 5.5 or above 9.5), which may result in damage or hazard to treatment-plant processing, and wastes containing metallic ions, which may inhibit treatment functions. Such interferences with treatment processes might result in downstream pollution that would not otherwise occur.

The Cleary-APWA phraseology provides, under "Prohibitions and Limitations," the following pertinent specifics:

> "Except as hereinafter provided, no person shall discharge into the public sewers: (a) any solids, liquids or gases which by themselves or by interaction with other substances may . . . be injurious to . . . the operation of the sewage-disposal works; . . . (b) any solids, greases, slurries or viscous material of such character or in such quantity that, in the opinion of the Approving Authority, may . . . interfere with the proper functioning of the sewage-disposal works; (c) any toxic substances, chemical elements or compounds in quantities sufficient to impair the operation or efficiency of the sewage-treatment facilities, or that will pass through the sewage-treatment plant and cause the effluent thereof to exceed state or interstate water-quality requirements for the receiving stream; (d) any liquids having a pH lower than ____ or higher than ____ , or having any corrosive property cabable of causing damage or hazards to . . . the sewage disposal works; (e) any radioactive isotopes without obtaining a special permit from the Approving Authority; (f) any liquid or vapor having a temperature greater than ____ degrees Fahrenheit; (g) any garbage that has not been ground or shredded." *Sec. 303*

It thereupon suggests a so-called special-agreements clause to vest discretion with the approving authority to negotiate arrangements on discharge of wastes of an unusual character. To permit the exercise of administrative flexibility, the wording suggested is:

> "No statement contained in this article shall be construed as prohibiting any special agreement or arrangement between the City and any person whereby an industrial waste of unusual strength or character may be admitted to the sewage disposal works, either before or after pretreatment, provided that there is no impairment of the functioning of the sewage-disposal works by reason of the admission of such wastes, and no extra costs are incurred by the City without recompense by the person." *Sec. 304*

Of similar import, and with specifics provided, Milford, Delaware, requires that:

> "Except as hereinafter provided, no person shall discharge or cause to be discharged any of the following described waters or wastes to any public sewer: (1) any liquid or vapor having a temperature higher than 150° F; (2) any water or waste which may contain more than 100 parts per million by weight, or fat, oil or grease; (3) any gasoline, benzene, naptha, fuel oil, or other flammable or explosive liquid, solid or gas; (4) any garbage that has not been properly shredded; (5) any ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, feathers, tar, plastics, wood, paunch manure or other solid or viscous substance capable of causing obstruction to the flow in sewers or other interference with proper operation of the sewage works; (6) any waters or wastes having a pH lower than 4.5 or higher than 9.0 or having any other corrosive property capable of causing damage or hazard to structures, equipment or personnel of the sewage works; (7) any waters or wastes containing a toxic or poisonous substance in sufficient quantity to injure or interfere with any sewage treatment process, constitute a hazard to humans or animals or create any hazard in the receiving waters of the sewage treatment plant (toxic wastes shall include wastes containing cyanide, copper and/or chromium ions); (8) any waters or wastes containing suspended solids of such character and quantity that unusual attention or expense is required to handle such materials at the sewage treatment plant except as may be approved by Council; (9) any noxious or malodorous gas or substance capable of creating a public nuisance." *Sec. 411.3.D*

Glossary

"CLEAN " WATERS—Used waters from industrial and commercial operations which are unpolluted by such uses and are relatively equivalent to the quality of the waters prior to such uses.

COMBINED SEWER—A sewer which receives and transports sanitary sewage, with or without industrial wastes, and storm-water runoff.

COMBINED SEWER OVERFLOW—The discharge into receiving waters of liquid wastes from combined sewers through outlet structures which regulate the amounts of flows either carried by trunk sewers or disposed of into such receiving water resources.

CURB-MILE—The distance of one mile of single curb length, or the length of one side of a street or other thoroughfare (distinguished from street-mile which normally represents two or more curbs or two sides of a street or other thoroughfare).

DUST AND DIRT FRACTION—The portion of street refuse which is smaller than ⅛ inch size.

MAXIMUM POLLUTIONAL POTENTIAL—The assumed amount of contaminants removed, in solution or suspended form, by precipitation and runoff waters from the maximum accumulation of street refuse between street cleaning operation. (In this report, the term relates to the amount of BOD potentially removable from an accumulation of 14 days of street litter during a two-hour runoff period).

PERVIOUS SOIL—Natural or indigenous soil which permits surface waters to filter or leach into the ground by natural drainage or percolation.

PRECIPITATION—Includes all forms—such as rain, snow, sleet, etc.

RUNOFF—The flow of waters from precipitation or thaw incidents from gutters into street inlets or from other connections into storm or combined-sewer systems.

SEPARATE STORM SEWER—A sewer which receives and transports storm-water runoff and not sanitary or industrial wastes.

SEPARATE STORM SEWER DISCHARGES—Waste waters which discharge into receiving waters through direct outlet pipes whenever runoff waters flow through separate storm sewers.

STREET REFUSE—Material which accumulates on streets and contiguous areas from various sources in the urban environment (term used interchangeably with street litter and street debris).

Abbreviations

avg.—average
BOD—Biochemical Oxygen Demand
cfm—cubic feet per minute
cfs—cubic feet per second
COD—Chemical Oxygen Demand
Cum.—Cumulative
cu. yd.—cubic yard
D/D—dust and dirt
D.U.—dwelling units
g—gram
gpm—gallons per minute
ha—hectare
kg—kilogram
lb—pound
l—litter
Max.—Maximum
mg—milligram
Min.—Minimum
MPH—miles per hour
MPN—most probable number
N—Nitrogen
P—Phosphorus
PE—Population Equivalent
ppm—parts per million
RPM—revolutions per minute
wt.—weight

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